Bingham Hall Comprehensive Renovation

Bid Set

Project Manual

January 8, 2024

SCO ID: 21-23548-02A

UNC CIP:21212

LAS Project No. 11706-00

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

LORD AECK SARGENT

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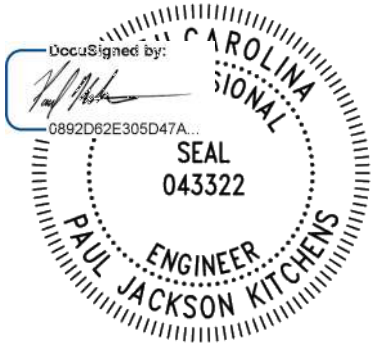

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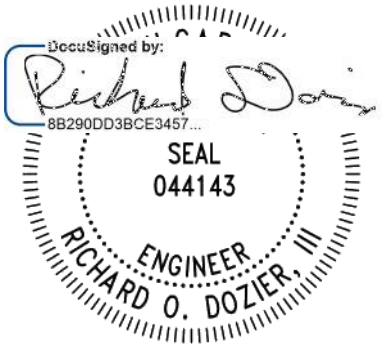

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ADVERTISEMENT FOR BIDS

Sealed proposals will be received until 9:00 AM on Tuesday, February 6, 2024, in the lobby of the Giles Horney Building, 103 Airport Drive, Chapel Hill, NC 27599 for the construction of:

University of North Carolina at Chapel Hill
Bingham Hall Comprehensive Renovation
SCO ID No.: 21-23548-02A
Code: 42123 Item: 301

Complete plans and specifications for this project can be obtained from the Designer:
Lord Aeck Sargent Planning & Design
Julia Sibert, RA
julia.sibert@lordaecksargent.com

The state reserves the unqualified right to reject any and all proposals.

Signed:
Quade Gallagher, AIA
Facilities Planning and Design
University of North Carolina at Chapel Hill

N O T I C E TO B I D D E R S

Sealed proposals will be received by The University of North Carolina at Chapel Hill, Department of Facilities Planning & Design in the Giles Horney Building, 103 Airport Drive, Chapel Hill, NC, 27599, up to 9:00 am on February 6, 2024, for the furnishing of labor, material and equipment entering into the construction of

Bingham Hall Comprehensive Renovation

Interior and exterior renovation of Bingham Hall. Site scope of work includes selective demolition, domestic water and fire line services with backflow devices, sanitary sewer service connection, fine grading, concrete, pavers, and landscape restoration. Building scope of work includes selective demolition and abatement, masonry repointing and stone repairs, strengthening of existing roof trusses, roof replacement, and interior construction. Building systems scope of work includes a full replacement of the mechanical, electrical, plumbing, and fire alarm systems. The fire protection system and infrastructure for low voltage are new to the building."

Bids will be received for Single Prime General Contract. All proposals shall be lump sum.

Pre-Bid Meeting

An open pre-bid meeting will be held for all interested bidders on January 16, 2024, at 1:00 pm, in Room 101 of the Facilities Construction Shops Building located at 101 Airport Drive, Chapel Hill, NC. The meeting will address project specific questions, issues, bidding procedures and bid forms.

The meeting is also to identify preferred brand alternates and their performance standards that the owner will consider for approval on this project.

In accordance with General Statute GS 133-3, Specifications may list one or more preferred brands as an alternate to the base bid in limited circumstances. Specifications containing a preferred brand alternate under this section must identify the performance standards that support the preference. Performance standards for the preference must be approved in advance by the owner in an open meeting. Any alternate approved by the owner shall be approved only where (i) the preferred alternate will provide cost savings, maintain or improve the functioning of any process or system affected by the preferred item or items, or both, and (ii) a justification identifying these criteria is made available in writing to the public.

In accordance with GS133-3 and SCO procedures the following preferred brand items are being considered as Alternates by the owner for this project:

Alternate No. PB-1: Owner Preferred Hydronic System Water Treatment

Alternate No. PB-2: Owner Preferred Variable Frequency Drive (VFD) Cables

Alternate No. PB-3: Owner Preferred Butterfly Valves

Alternate No. PB-4: Owner Preferred Balancing Valves

Alternate No. PB-5: Owner Preferred Pressure Reducing Valves

Alternate No. PB-6: Owner Preferred Mechanical Access Doors

Alternate No. PB-7: Owner Preferred Drinking Fountains

Alternate No. PB-8: Owner Preferred Door Hardware

Alternate No. PB-9: Owner Preferred Tile Carpet

Justification of any approvals will be made available to the public in writing no later than seven (7) days prior to bid date.

Complete plans, specifications and contract documents will be available from the Designer:
Lord Aeck Sargent Planning & Design
Julia Sibert
Julia.Sibert@lordaecksargent.com

Documents are also available from the following plan rooms:

Construction Connect - https://projects.constructconnect.com/
Dodge - https://planroom.construction.com/
NC IMED - https://theinstitutenc.org/calendar/category/bid-opportunities/

A hard copy may be obtained by those qualified as prime bidders, upon deposit of seven hundred dollars ($700) in cash or certified check to Lord Aeck Sargent. The full plan deposit will be returned to those bidders provided all documents are returned in good, usable condition within ten (10) days after the bid date.

NOTE: The bidder shall include with the bid proposal the form *Identification of Minority Business Participation* identifying the minority business participation it will use on the project and shall include *Affidavit **A***. Forms and instructions are included within the Proposal Form in the bid documents. Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2c Effective 1/1/2002.)

All contractors are hereby notified that they must have proper license as required under the state laws governing their respective trades.

General contractors are notified that Chapter 87, Article 1, General Statutes of North Carolina, will be observed in receiving and awarding general contracts. General contractors submitting bids on this project must have license classification for Building Contractor, Unlimited License.

> NOTE--SINGLE PRIME CONTRACTS: Under GS 87-1, a contractor that superintends or manages construction of any building, highway, public utility, grading, structure or improvement shall be deemed a "general contractor" and shall be so licensed. Therefore a single prime project that involves other trades will require the single prime contractor to hold a proper General Contractors license. **EXCEPT**: On public buildings being bid single prime, where the total value of the general construction does not exceed 25% of the total construction value, contractors under GS87- Arts 2 and 4 (Plumbing, Mechanical & Electrical) may bid and contract directly with the Owner as the SINGLE PRIME CONTRACTOR and may subcontract to other properly licensed trades. GS87-1.1- Rules .0210

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company, insured by the Federal Deposit Insurance Corporation, of an amount equal to not less than five percent (5%) of the proposal, or in lieu thereof a bidder may offer a bid bond of five percent (5%) of the bid executed by a surety company licensed under the laws of North Carolina to execute the contract in accordance with the bid bond. Said deposit shall be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten days after the award or to give satisfactory surety as required by law.

A performance bond and a payment bond will be required for one hundred percent (100%) of the contract price.

Payment will be made based on ninety-five percent (95%) of monthly estimates and final payment made upon completion and acceptance of work.

No bid may be withdrawn after the scheduled closing time for the receipt of bids for a period of 30 days.

The owner reserves the right to reject any or all bids and to waive informalities.

Designer:
Lord Aeck Sargent Planning & Design
Attn: Julia Sibert, RA
1450 Raleigh Rd, Ste 109
Chapel Hill, NC 27517
(919) 913-2672

Owner:
The University of North Carolina at Chapel Hill
Facilities Planning and Design
Attn: Quade Gallagher, AIA
103 Airport Drive
Chapel Hill, NC 27599
(919) 843-2087

Hazardous Materials Assessment
UNC Chapel Hill – Bingham Hall
Chapel Hill, North Carolina
S&ME Project No. 218984

PREPARED FOR:

Lord Aeck Sargent
1450 Raleigh Road
Chapel Hill, North Carolina 27517

PREPARED BY:

S&ME, Inc.
3201 Spring Forest Road
Raleigh, North Carolina 27616

March 29, 2022

March 29, 2022

Lord Aeck Sargent
1450 Raleigh Road
Chapel Hill, North Carolina 27517

Attention: Ms. Kelly Yates, AIA
Via Electronic Mail: kelly.yates@lordaecksargent.com

Reference: **Hazardous Materials Assessment**
UNC Chapel Hill – Bingham Hall
Chapel Hill, North Carolina 27514
S&ME Project No. 218984

Dear Ms. Yates:

S&ME, Inc. (S&ME) provides the enclosed report detailing our Hazardous Materials Assessment of Bingham Hall located on the campus of The University of North Carolina – Chapel Hill, in Chapel Hill, North Carolina. The purpose of the assessment was to identify asbestos containing materials (ACM) in the interior and exterior of the building, lead painted surfaces, polychlorinated biphenyls (PCBs), and other potential contaminants. Our field services were performed on February 23, 2022, and March 3, 2022, in general accordance with S&ME Proposal No. 218984, dated November 30, 2021. The following report includes the project background, sampling and analysis procedures, findings and results, and conclusions recommendations, as necessary.

This report is provided for the sole use of Lord Aeck Sargent and UNC Chapel Hill. Use of this report by any other parties will be at such party's sole risk, and S&ME disclaims liability for any such use or reliance by third parties. The results presented in this report are indicative of conditions only during the time of the assessment and of the specific areas referenced.

S&ME appreciates this opportunity to provide our services to you. Please call if you have questions concerning this report or any of our services.

Sincerely,

S&ME, Inc.

Colby L. Paine, ASP
Industrial Hygienist/Associate Project Manager

Janet K. Phillips
Senior Project Manager

Senior Review: Christopher B. Murray, CIH, CSP

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Appendices

Executive Summary

S&ME Inc. (S&ME) conducted a Hazardous Materials Assessment of Bingham Hall located on the campus of The University of North Carolina at Chapel Hill, in Chapel Hill, North Carolina. The purpose of the assessment was to identify asbestos containing materials (ACM) in the interior and exterior of the building, painted surfaces containing lead, polychlorinated biphenyls (PCBs) and other potential contaminants.

UNC Department of Environment, Health, and Safety (UNC-EHS) provided the project team with previous sampling data for asbestos, lead, and mold complaint reports. S&ME reviewed the reports and utilized the information during the investigation.

An ACM is defined by State and Federal regulations as a building material containing greater than one percent (>1%) of one of the six asbestos minerals regulated by the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA).

OSHA classifies paint containing any detectable levels of lead as lead paint for purposes of complying with OSHA regulations regarding worker exposure (29 CFR 1926.62 – Lead in Construction).

Based on the representative bulk samples collected from the interior and exterior of the building and analyzed by polarized light microscopy (PLM) as a part of this assessment, the materials listed in Table E-I-1 were identified as ACM:

Table E-I-1 Identified Asbestos-Containing Materials

HA	Material Description	[1] Location	[2] Approximate Quantity
T	Air Cell pipe insulation	8" steam line running from south crawlspace wall to north crawlspace	310 LF
U	Hard elbow on Air Cell	Elbows on Air Cell insulation	60 fittings
Y	Window caulk	Around exterior side of windows	195 windows
N/A	Contaminated soil (depths of contamination vary)	Crawlspace	Approx. 2,000 SF

HA = Homogenous Area SF = Square feet LF = Linear feet CF = Cubic feet

[1] Refer to Appendix II for specific sample locations.

[2] Quantities are approximate and should not be used for cost estimates or bidding purposes.

Lead was identified in each of the three analyzed paint samples. Each of the three samples contained lead concentrations above 0.5%, which is the threshold for lead-based paint. Lead containing paint was identified by UNC-EHS on the plaster walls. Disturbance of building components coated with lead-containing or lead-based paint will require compliance with the OSHA Lead in Construction Standard 29 CFR 1926.62.

PCBs were not identified in exterior window caulk. No caulk was noted around the exterior side of doors.

Fluorescent light bulbs were identified in the facility. Compact Fluorescent Light (CFL) bulbs/tubes may contain low amounts of mercury and breakage of the bulbs during renovation or demolition activity would release the mercury vapor into the atmosphere. Proper disposal of the light bulbs should be performed prior to future renovation or demolition projects that will impact or damage the bulbs. Fluorescent light ballasts (FLB) and light tubes were present in the hallways and classrooms. Light fixtures were not deconstructed due to FLBs being in use, energized and the potential risk of electric shock.

A box of No. 6 Eveready Dry Cell Batteries was identified in the attic along with asbestos insulated wiring. These items will be treated as asbestos waste and universal waste.

Visible mold was identified on the metal support beams in the attic. Cleaning the metal beams with an antimicrobial agent will be incorporated within the scope of work.

The elevator is scheduled to be reused; thus, an assessment associated with the hydraulic fluids and capacitors was not performed.

The roof was not assessed due to unsafe access conditions and the lack of a fall arrest system. S&ME assumes any caulking associated with the slate roof will be treated as ACM.

Prior to renovation activities that will disturb the equipment, proper disposal or recycling of equipment containing CFCs in accordance with all federal, state, and local regulations is recommended.

This executive summary is presented solely for introductory purposes, and the information contained in this section should be used only in conjunction with the full contents of this report, including appended materials.

1.0 Introduction

Lord Aeck Sargent retained S&ME to conduct a hazardous materials assessment of Bingham Hall located on the campus of UNC Chapel Hill prior to a complete renovation. The assessment was performed by Mr. Colby Paine and Ms. Janet Phillips on February 23, 2022, and by Mr. Paine and Mr. Ben Best on March 3, 2022, in general accordance with S&ME Proposal No. 218984, dated November 30, 2021. The assessment included the entire structure, including the roofing system. The roof was not assessed because the pitched roof imposed an unsafe condition without a fall arrest system.

1.1 Asbestos

An ACM is defined by State and Federal regulations as a building material containing greater than one percent (>1%) of one of the six asbestos minerals regulated by the Environmental Protection Agency (EPA) and OSHA. Demolition and renovation in public and commercial buildings are regulated by OSHA and EPA and in the US Virgin Islands. The EPA require asbestos assessments, conducted by EPA accredited individuals, prior to renovation and/or demolition projects. Code 40 of Federal Regulations Part 61, Subpart M, Final Rule, National Emissions Standards for Hazardous Air Pollutants (NESHAP) require asbestos assessments, followed by the proper removal, and disposal of ACM that is affected by renovation or demolition. The identification of ACMs will aid in the prevention of occupational exposures and/or environmental releases of airborne asbestos. Identification of ACM is also required by OSHA 1926.1101. The EPA and OSHA define ACM as materials containing greater than one (1)

percent asbestos in a representative sample. However, OSHA also regulates materials containing less than or equal to one percent asbestos.

1.2 Lead

The Environmental Protection Agency (EPA) defines lead-based paint (LBP) as paint having a lead content of greater than or equal to 0.5 weight percent using laboratory analysis. Paint containing detectable lead levels less than 0.5 weight percent using laboratory analysis is considered lead-containing paint (LCP). The Occupational Safety and Health Administration (OSHA) regulates worker exposure to lead regardless of the content of lead in paint. Loose chips, flake, dust, paint residue, paint removed from surfaces or paint dust accumulations of LBP (excluding residential) must be tested using the Toxicity Characteristic Leachate Procedure (TCLP) to determine if it is hazardous waste. Metals painted with LBP can be recycled without removing the paint.

Demolition activities (e.g., component removal, demolition, sanding, grinding, burning, paint preparation, paint disturbance) involving LBP and LCP are covered under the OSHA Construction Industry Standard for Lead (Title 29 of the Federal Code of Regulations, Part 1926.62). OSHA compliance may require worker training, medical evaluations, personnel protective equipment, exposure assessment, air monitoring, hygiene facilities and practices, and health and safety plans. OSHA regulations do not define a minimum concentration of lead as a threshold for action. Thus, lead concentrations in paint below EPA levels are regulated by OSHA.

The lead assessment is intended to assess the need for the safe and proper management of painted surfaces during renovation or demolition of the building. The assessment and the resultant sample data are not meant to assess current or future building occupant exposure or to represent a risk assessment. Sampling of representative painted materials was performed as part of this assessment.

1.3 Polychlorinated Biphenyls (PCB)

1.3.1 Lamp Ballasts

PCBs were banned in the United States in 1976. From 1978 to July 1, 1998, the EPA required manufacturers to mark light ballasts that do not contain PCBs with the statement "No PCBs." Since this is no longer a requirement of manufacturers, ballasts installed after 1998 with no identifiable PCB labeling is not considered PCB containing. Ballasts that are encountered during the demolition process that do not exhibit the "No PCBs" labeling that were installed prior to July 1, 1998, are required by the EPA to be disposed of in accordance with 40 CFR 761, subpart D of the Toxic Substance Control Act (TSCA) or sampled to determine the absence or presence of PCB levels. We recommend recycling, high temperature incineration, or disposal of any suspect PCB containing equipment in a hazardous waste landfill. Sampling and testing of suspected PCB containing equipment was not performed as part of this assessment.

1.3.2 Caulk and Sealants

PCBs may be present in caulk and other sealant materials used in building construction between 1950 and approximately 1980. PCBs were a common additive to caulk and sealants because of their water and chemical resistance, durability, and elasticity. PCBs were added as a plasticizer in caulk used to seal joints between masonry units and around windows. Materials containing greater than 50 parts per million (ppm) must be disposed of in an

EPA Toxic Substance Control Act (TSCA) approved landfill. No suspected PCB containing caulks and sealants were identified as part of this assessment.

1.4 Mercury

Mercury containing items are designated as a Universal Waste by the EPA under 40 CFR 273, the Resource Conservation and Recovery Act (RCRA). The EPA requires the proper handling, shipping and disposal of mercury containing sources as part of the Universal Waste Rule (UWR). The mercury assessment was conducted to identify liquid mercury or mercury vapor containing items associated with the building. Mercury-containing items include, but are not limited to, thermostats, thermometers, barometers, pressure gauges, switches, batteries, and fluorescent lamp tubes, and other mercury-containing lamps. Sampling and testing of suspect mercury containing items was not performed as part of this assessment.

1.5 Refrigerants (Chlorofluorohydrocarbons)

The use, management, and release of refrigerants, such as chlorofluorohydrocarbons (CFCs), are regulated under the Clean Air Act (CAA) of 1990. Section 608 of the CAA forbids the venting of regulated refrigerants such as CFC refrigerants, as they deplete the ozone in the atmosphere. The refrigerants assessment was conducted to identify potential CFC containing equipment associated with the structure. Sampling and testing of suspect CFC containing equipment was not performed as part of this assessment.

1.6 Other Hazardous Materials and Universal Wastes

Universal Wastes are hazardous wastes that should be removed prior to renovation or demolition but are handled and disposed of differently than other hazardous waste. Universal Waste are handled and disposed of per 40 CFR Part 273 and includes batteries, pesticides, mercury-containing equipment, lamps, and aerosol cans. Universal Wastes are typically recycled.

1.7 Mold

There are currently no federal regulations for indoor mold, however mold regulations are available in some states. Although mold is ubiquitous and mold spores are present indoors, visible growth on building surfaces is a clear indicator that mold has colonized on a particular substrate or material. In most cases, the discovery of visible mold indoors warrants cleanup of non-porous contaminated materials and removal and disposal of porous contaminated materials (e.g., insulation and sheetrock). Semi-porous materials, such as wood and wood products, are generally remediated (i.e., cleaned or removed and disposed) on a case-by-case basis depending on the type of material, degree of contamination or water damage, replacement cost, and structural integrity. Interior mold growth is primarily caused by water intrusion/damage, condensation, or elevated indoor humidity.

2.0 Site and Project Description

2.1 Purpose

The purpose of the assessment was performed in general accordance with S&ME Proposal No. 218984, dated November 30, 2021. The assessment included the entire structure, including the roofing system. The roof was not assessed because the pitched roof imposed an unsafe condition without a fall arrest system.

- Inspect the subject property for the presence of suspect ACMs, lead-containing paint and materials, mercury-containing products, PCB lighting ballasts and sealants, chlorofluorocarbon (CFC) containing equipment, universal wastes, and mold.
- Collect samples of suspect ACMs following a National Emissions Standards for Hazardous Air Pollutants (NESHAPS) protocol for sample collection for a renovation or demolition survey. Asbestos bulk samples were analyzed using polarized light microscopy (PLM) in accordance with the EPA's July 1993 method for the determination of asbestos in bulk building materials - EPA 600/R-93/116.
- Collect bulk paint chip samples of primary or representative painted surfaces and other materials suspected to be lead containing. Bulk samples were analyzed at an accredited laboratory by Flame Atomic Absorption (AA) for Total Lead reported in parts per million (ppm) and concentration % by weight.
- An inventory of other potential hazardous materials and regulated Universal Wastes.
- Visual assessment for readily accessible mold and/or moisture impacted building materials.

An assessment strategy believed by S&ME to be appropriate for this purpose is described in this report. The report should be interpreted only with regard to the specific location and materials referenced.

2.2 Site Description

The onsite building consists of a three-story building, with a sub-grade basement. The building was previously used as an office/classroom academic building. Building materials sampled for asbestos during this assessment include floor tile and mastic, plaster walls, cove base and glue, terrazzo flooring, fire door interior, ceiling tiles, window caulk, window glazing putty, tile and grout, vapor barrier/water proofing on subfloor, gypsum board, plaster texture, foundation water proofing, air cell pipe insulation, hard elbows on insulation, firestop, and plywood underlayment. Substrates sampled for lead paint included metal radiators, and metal window frame/casing. FLBs and CFCs were noted and included within the assessment

3.0 Assessment Methods

3.1 Asbestos

A visual assessment of the referenced structure was performed to determine the HAs of suspect ACMs. Based on EPA definitions used in the Asbestos Hazard Emergency Response Act (AHERA), 40 CFR 763, an HA of asbestos-suspect building material has the same color and texture and is thought to be installed within the same timeframe. S&ME assessed the interior of the building and exterior of the building, including roofing materials for suspect ACMs, including thermal system insulation (TSI), surfacing materials, and miscellaneous materials. Representative samples of asbestos-suspect building materials were collected from each HA in accordance with the EPA's AHERA protocol and applicable State regulations.

Information regarding the bulk samples of each HA was collected, recorded on a chain of custody record, and submitted to Eurofins/CEI located in Cary, NC for analysis by Polarized Light Microscopy (PLM) coupled with dispersion staining in general accordance with the EPA 600/R-93/116 Method. Laboratories used for sample analysis are accredited by the National Voluntary Laboratory Accreditation Program (NVLAP), which is administered by the National Institute of Standards and Technology (NIST). The laboratory analysis reports the specific type of asbestos mineral identified (if any) and the percentage of asbestos present in each sample.

Pursuant to the EPA NESHAP, friable materials containing less than ten percent asbestos must be considered an ACM unless follow-up analysis by the Point Count Method reports less than one percent asbestos. Samples reported with a quantity less than one percent by the Point Count Method are not ACM and are not regulated by the EPA, however disturbance of materials containing less than one percent asbestos are regulated by OSHA in 29 CFR 1910.1101 to prevent worker exposure to asbestos.

Although PLM (Method EPA 600/R-93/116) is the recommended method for analysis of bulk material samples for asbestos fibers under the EPA AHERA, there have been reports that this method alone may not identify asbestos when fiber sizes are extremely small or if they are bound in a resinous material. Typical examples of these materials include but are not limited to; floor tile and associated mastic/adhesive, vinyl sheet flooring (linoleum) and associated mastic/adhesive, roof shingles, asphaltic roof materials, glazing, caulking, cove base mastic, and other construction mastics/adhesives. Currently, reanalysis by Electron Microscopy (EM) to verify results of less than one percent or "None Detected" for these materials is recommended by EPA but not currently required. EM analysis has not been performed as a part of this survey effort.

Wall finishes composed of gypsum board finished with joint compound observed only at gypsum board seams and fastener holes were sampled as a composite sample (samples include both the wallboard and the joint compound). Current EPA interpretations allow that the components of these gypsum board systems may be considered as a single homogeneous area/material. Accordingly, the presence of greater than one percent asbestos in a composite sample analysis identifies the sample as ACM. If the composite sample analysis (both joint compound and wallboard) is reported as “trace” or less than or equal to one percent asbestos, the sample must be further analyzed using the Point Count Method or be considered to be ACM under EPA regulations. Materials containing asbestos with less than or equal to one percent asbestos are regulated by OSHA 29 CFR 1926.1101 and specific requirements apply during disturbance or abatement.

Identified ACM were assessed based on the observed condition (good, fair, or poor) and potential for disturbance due to the scheduled renovation/demolition. Identified ACM were also categorized based on the EPA’s NESHAP regulation categories. Friable ACM is classified as an ACM that can be crumbled to a powder by moderate hand pressure. Non-friable ACM is classified as either Category I Non-friable ACM or Category II Non-friable ACM. Category I and Category II Non-friable ACM are distinguished from each other by their fiber release potential when damaged. Generally, Category I Non-friable ACM, which by definition includes intact ACM roofing materials, gaskets, packing, and resilient floor coverings is less likely to become friable and release fibers in a damaged state. Category II Non-friable ACM include all other non-friable ACM excluding Category I that have a high probability of being rendered friable during removal activities or demolition. All Friable ACM, Category I Non-friable ACM that has become friable, Category I Non-friable ACM that will be or has been subjected to sanding, grinding, cutting or abrading, or Category II Non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations are considered to be a Regulated Asbestos-Containing Material (RACM). The NESHAP category for each identified ACM is provided in Table 4-1.

3.2 Lead

A visual assessment of the structure was performed to identify primary and unique testing combinations of paint suspected of containing lead. Determination of a unique testing combination of paint is based on paint color, building component, and substrate. The representative painted finishes were selected based on the color of the topcoat and the underlying paint layers and/or the substrate on which it was applied and the use of the paint as a

primary paint used throughout the building. The EPA defines LBP as paint having a lead content of greater than or equal to 0.5 weight percent using laboratory analysis. Paint containing detectable lead levels but less than 0.5 weight percent using laboratory analysis is considered LCP. Paints with detectable levels of lead are considered LCP and are regulated by OSHA. OSHA does not recognize a threshold level of lead for definition purposes, only the airborne concentration of lead a worker is exposed to when disturbing.

Paint (chip) samples were collected from representative interior and exterior painted components associated with the referenced building by physically removing a small portion (approximately two square inches) from the substrate using a cutting or coring tool. Each sample was placed into a sealed and labeled container, and sample locations and descriptions were recorded. The chip samples were submitted to The samples were documented on a chain of custody record and submitted to SAI Laboratories, a National Lead Laboratory Accreditation Program accredited laboratory for analysis by Atomic Absorption Analysis (AAS), in Greensboro, North Carolina for analysis by AAS to quantify lead content.

3.3 PCB

3.3.1 Lamp Ballasts

S&ME observed lamp ballast associated with fluorescent lamp fixtures in the aforementioned building. PCBs are regulated by the EPA under 40 CFR 761, the Toxic Substance Control Act (TSCA). The identification of these materials will need to be determined for proper handling and disposal of identified PCB containing sources. Sampling or testing of suspected PCB containing lamp ballasts was not performed as part of this screening.

3.3.2 Caulk and Sealants

S&ME performed a visual assessment of readily accessible caulk and sealant materials that may contain PCBs at concentrations greater than 50 ppm. The visual assessment included evaluation of the condition of the caulk or sealant, i.e., peeling, cracking, flaking, brittleness. Representative sample of caulk material was collected to determine the presence of PCBs associated with the windows. The exterior sides of the doors did not appear to have caulking or sealants around them. A bulk sample was collected by removing sections of the caulk using stainless steel razor blades. The sample was placed in a glass jar and delivered to the laboratory.

The sample was submitted to Pace Analytical Laboratories in Huntersville, North Carolina. Pace Analytical participates in the National Environmental Laboratory Accreditation Program (NELAP). The sample was analyzed by gas chromatography following EPA Method SW-846-3540C/8082A in compliance with the Resource Conservation and Recovery Act (RCRA).

3.4 Mercury

A visual assessment was conducted by observing thermostats, fluorescent lamps, and any apparent items that may contain mercury. Mercury is designated as a Universal Waste by the EPA under 40 CFR 273, the Resource Conservation and Recovery Act (RCRA) and requires proper handling and disposal of mercury containing items. The identification of these materials will aid in the prevention of occupational exposures and/or environmental releases of mercury and provide information to facilitate proper disposal of mercury containing items in accordance with EPA Universal Waste requirements. No components suspected to contain mercury were identified during the assessment.

3.5 Refrigerants (Chlorofluorohydrocarbons)

A visual assessment was performed for the presence of cooling or refrigeration equipment that may contain chlorofluorohydrocarbons (CFCs). The use, management, and release of ozone depleting substances, such as CFCs, used as refrigerants are regulated under the Clean Air Act (CAA) of 1990. Sampling or testing was not performed as part of this assessment.

3.6 Other Hazardous Materials and Universal Wastes

At the time of the assessment, S&ME evaluated and quantified potential regulated Universal Waste within the structure to obtain information on the potential presence of other hazardous materials that require removal and disposal prior to renovation/demolition. For these materials, visual observation was used to assess the presence of hazardous materials or suspected Universal Wastes, as no laboratory testing was conducted.

3.7 Mold

A limited visual assessment was performed for the presence of mold and/or moisture impacted materials on interior surfaces of the building. Observations were limited to readily accessible areas and surfaces where mold or water damage was readily apparent. Air sampling and surface sampling for mold was not performed as part of this assessment.

4.0 Results

4.1 Asbestos Results

Based on the representative bulk samples collected from the interiors of the building and analyzed by polarized light microscopy (PLM) as a part of this assessment, there were materials identified to contain asbestos. Asbestos containing materials identified during this assessment are provided in **Table 4-3** below:

Table 4-3: Identified Asbestos-Containing Materials

HA	Material Description	[1] Location	[2] Approximate Quantity
T	Air Cell pipe insulation	8" steam line running from south crawlspace wall to north crawlspace	310 LF
U	Hard elbow on Air Cell	Elbows on Air Cell insulation	60 fittings
Y	Window caulk	Around exterior side of windows	195 windows
N/A	Contaminated soil (depths of contamination vary)	Crawlspace	Approx. 2,000 SF

HA = Homogenous Area SF = Square feet LF = Linear feet CF = Cubic feet

[1] Refer to Appendix II for specific sample locations.

[2] Quantities are approximate and should not be used for cost estimates or bidding purposes.

The summary of bulk asbestos results for this assessment is provided in **Appendix I**. Photographs depicting materials found to contain asbestos and sample location field drawings are provided in **Appendix II**. A copy of

the asbestos inspector's accreditation is provided in **Appendix III**. The laboratory report and chain of custody records are provided in **Appendix IV**.

During the March 3, 2022, site visit, soil contamination in the crawl space was noted. Broken and damaged air cell pipe insulation was noted as having fallen off of the piping above it. The area of soil contamination runs the length of the pipe run with the air cell insulation applied and extends approximately 7-8 feet inward from the foundation walls. The area of contaminated soil is estimated to be ~1,500-2,000 square feet (depths of contamination vary).

4.2 Lead Results

Lead was detected in each of the three paint samples collected at levels above the laboratory detection limit. Each of the three samples exceeded the 0.5% by weight lead content for classification as a lead-based paint.

The summary of paint sample results for this assessment is provided in **Appendix I**. The laboratory report and chain of custody records are provided in **Appendix IV**.

Table 4-2: Summary of Lead Paint Results

Sample ID No.	Description	Location	Percent Lead by Weight	Condition
Pb-01	Cream paint on metal radiator	Room	0.60%	Flacking and Cracking
Pb-02	Cream on metal interior window casing	Room	0.66%	Flaking and cracking
Pb-03	Tan on exterior metal window frame	Exterior	13%	Flaking and cracking

4.3 PCB Results

PCBs were not detected in the window caulk sample at levels above the laboratory detection limit.

Table 4-1: Summary of PCB Caulk Sample Results

Sample ID No.	Description	Location	PCB Concentration (Parts per million)	Condition
PCB-01	Window caulk	North exterior wall, east window	None Detected	Cracking

Bold indicates PCB concentration greater than the EPA 50 ppm bulk product waste threshold.

The laboratory and chain of custody record for the collected PCB samples are provided in **Appendix IV**.

4.4 Other Hazardous Waste

A box of No. 6 Eveready Dry Cell Batteries was identified in the attic along with asbestos insulated wiring. It is unknown if the batteries currently retain a charge. Research indicates the batteries are comprised of zinc chloride, which is corrosive, toxic and is considered a chronic hazard to all aquatic environments, ultimately, affecting drinking water. S&ME reached out to Mr. Steve Parker, EHS Hazardous Waste Specialist, concerning any specific requirements UNC may require related to the disposal of the batteries. It appears Mr. Steve Parker is out on medical leave and was non-responsive.

4.5 Mold

No visible mold was identified during the assessment on surfaces within the interior of the building. S&ME did notice the metal support beams in the attic with visible mold growth.

5.0 Conclusions and Recommendations

5.1 Asbestos Conclusions/Recommendations

Asbestos containing materials *were* identified during this assessment.

Asbestos containing materials include pipe insulation and hard elbows on pipe insulation, exterior window caulking and contaminated soil.

TSI and contaminated soil, Category II ACM, were identified during the assessment. We recommend proper removal and disposal of the asbestos materials by an accredited asbestos abatement contractor, prior to any demolition activities. State and Federal regulations should be carefully considered to verify compliance before any actions are initiated that may disturb an ACM. If additional suspect ACMs not included in this report are discovered during the demolition activities, bulk samples must be collected by an accredited asbestos inspector and analyzed for asbestos content. The removal of the contaminated soil will require an abatement contractor to remove the contaminated soil at varying depths. Some locations the contamination appears to be on the top surface of the soil whereas in other locations it may be found from half an inch to an inch deep.

As addressed in the NESHAP Regulations, asbestos removal requires written notification to HHCU, specific removal procedures, proper transportation, and disposal per state and federal regulations. The identification and proper removal of ACM prior to demolition or renovation will aid in the prevention of occupational exposures and/or environmental releases of airborne asbestos. If ACMs are managed in place, OSHA requirements apply to employees that may contact or disturb ACMs, including maintenance and custodial workers.

5.2 Lead Conclusions/Recommendations

Lead was detected in each of the three paint samples collected at levels above the laboratory detection limit, and above the 0.5% by weight lead-based paint threshold.

The following precautions apply to lead-containing and lead-based paint as they relate to the construction industry:

- The OSHA Lead in Construction Standard stipulates a maximum worker exposure limit, referred to as the Permissible Exposure Limit (PEL), of 50 micrograms per cubic meter (µg/m^3) over an eight-hour time weighted average (TWA). The standard requires monitoring the lead level in the worker's blood (workers blood lead level) when exposed to airborne lead at or above the Action Level of 30 µg/m^3 over an eight-hour TWA. OSHA requires the employer to make an initial determination of whether an employee's exposure to lead exceeds the Action Level over an eight-hour TWA. Monitoring at the breathing zone of the employee is required unless the employer has objective data demonstrating the employees will not be exposed to lead in excess of the Action Level.

- North Carolina solid waste disposal regulations do not stipulate disposal requirements for components coated with lead-containing paint or lead-based paint, meaning the construction debris can be discarded in a construction and demolition landfill. If the paint is removed from the substrate/component, samples must be collected and tested using the Toxic Characteristic Leaching Procedure (TCLP) to determine the waste stream.

- It should be noted that the lead assessment is intended to assess the need for the safe and proper management of painted surfaces during renovation or demolition of the building. The assessment and the resultant sample data are not meant to assess current or future building occupant exposure or to represent a risk assessment. This assessment does not fulfill the requirements of a Housing and Urban Development (HUD) lead risk assessment.

5.3 PCB Conclusions/Recommendations

PCBs were not detected in the caulk sample collected at levels above the laboratory detection limit. The exterior window caulk is not considered a PCB bulk product waste, as defined by the EPA.

TSCA defines PCB bulk product waste as waste derived from manufactured products containing PCBs in a non-liquid state in which the concentration at the time of designation for disposal is greater than or equal to 50 parts per million (ppm), which includes, but is not limited to, caulking.

The FLBs and CFCs will be discarded and packaged for disposal as universal waste or regulated hazardous waste.

5.4 Mercury Conclusions/Recommendations

The fluorescent lamp tubes located in the referenced structure's light fixtures may contain low levels of mercury and must be recycled or properly disposed as mercury sources. Mercury is designated as a Universal Waste by the EPA under 40 CFR 273, from the Resource Conservation and Recovery Act (RCRA). If the light tubes and bulbs will not be reused, S&ME recommends the light tubes and bulbs be removed and properly recycled or disposed of prior to demolition activities in accordance with federal, state, and local regulations.

If any mercury sources that were not previously identified are discovered during destructive work activities, we recommend removal, handling, and disposal as a Universal Waste.

5.5 Refrigerants (Chlorofluorohydrocarbons) Conclusions/Recommendations

The use, management, and release of ozone depleting substances used as refrigerants are regulated under the Clean Air Act (CAA) of 1990. Section 608 of the CAA forbids the venting of regulated refrigerants such as CFC, HCFC, or blended refrigerants. All regulated refrigerants associated with the buildings and equipment must be recovered for reuse or proper disposal prior to severing pressurized systems or disposal of equipment.

5.6 Other Hazardous Waste Conclusions/Recommendations

Due to quantity of zinc chloride used in the No. 6 Dry Cell batteries identified in the attic, the batteries will be discarded as universal waste and the asbestos wiring will be disposed of with the asbestos waste.

5.7 Mold Conclusions/Recommendations

Visible mold was identified on the metal support beams in the attic. Cleaning the metal beams with an antimicrobial agent shall be incorporated within the scope of work.

6.0 Assumptions and Limitations

This report is provided for the sole use of the Client. Use of this report by any other parties will be at such party's sole risk, and S&ME disclaims liability for any such use or reliance by third parties. The results presented in this report are indicative of conditions only during the time of the sampling period and of the specific areas referenced. Under no circumstances is this report to be used as a bidding document, or as a project design or specification.

S&ME performed the services in accordance with generally accepted practices of reputable environmental consultants undertaking similar studies at the same time and in the same geographical area. S&ME has endeavored to meet this standard of care. No other warranty, expressed or implied, is intended or made with respect to this report or S&ME's services. Users of this report should consider the scope and limitations related to these services when developing opinions as to risks associated with the site.

The limited asbestos assessment was not destructive. Samples were collected from inconspicuous locations inside the building. The possibility exists that suspect materials were undetected in inaccessible or concealed areas such as under concrete floors, and inside pipe chases or wall voids. If additional suspect materials are discovered during future destructive activities, bulk samples must be collected by an accredited asbestos inspector and analyzed for asbestos content, or the suspect material should be presumed to contain asbestos be treated as an ACM.

Appendices

Appendix I – Summary of Sampling Results

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
A	**Type:**	Floor tile and mastic	Large classrooms	NA	I	Misc	Fair	High	A-01		Room 317		ND
	Texture:	Smooth							A-02		Room 309		ND
	Color:	Taupe											
	Size:	12"x12"											
	Other:												
B	**Type:**	Floor tile and mastic	Large classrooms	NA	I	Misc	Fair	High	B-01		Room 317		ND
	Texture:	Smooth							B-02		Room 301		ND
	Color:	White w/ taupe streaks											
	Size:	12"x12"											
	Other:												
C	**Type:**	Floor tile and mastic	Edge of large classrooms	NA	I	Misc	Good	High	C-01		Room 309		ND
	Texture:	Smooth							C-02		Room 317		ND
	Color:	Burgundy											
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

Quantities are approximate and should not be used for cost estimates or bidding purposes.

ND = None Detected NA = Not Applicable HA = Homogenous Area

[1]**Quantity**: SF = Square Feet LF = Linear Feet CF = Cubic Feet

[2]**Category**: F = Friable I = Category I, Non-Friable II = Category II, Non-Friable

[3]**Type**: Misc = Miscellaneous Sur = Surfacing TSI = Thermal System Insulation

[4]**Condition**: Good, Fair, or Poor

[5]**PFD**: Potential for Disturbance due to Renovation or Demolition: Low or High

[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
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HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
D	**Type:**	Plaster	Walls and ceilings throughout most of building	NA	II	Sur	Fair	High	D-01		Room 317 west wall		ND
	Texture:	Smooth, with some textured areas							D-02		Room 317 east wall		ND
	Color:	White							D-03		First floor, north janitor closet, room 127		ND
	Size:												
	Other:												
E	**Type:**	Covebase and glue	Base of walls in classrooms and in closets	NA	II	Misc	Fair	High	E-01		Room 317		ND
	Texture:	Smooth							E-02		Room 217		ND
	Color:	Black covebase, brown/yellow glue											
	Size:												
	Other:												
F	**Type:**	Terazzo flooring	Hallways throughout each floor	NA	II	Misc	Good	High	F-01		Hallway outside room 311		ND
	Texture:	Smooth							F-02		Hallway outside room 209		ND
	Color:	Brown											
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

Quantities are approximate and should not be used for cost estimates or bidding purposes.

	ND = None Detected	NA = Not Applicable	HA = Homogenous Area
[1]**Quantity**:	SF = Square Feet	LF = Linear Feet	CF = Cubic Feet
[2]**Category**:	F = Friable	I = Category I, Non-Friable	II = Category II, Non-Friable
[3]**Type**:	Misc = Miscellaneous	Sur = Surfacing	TSI = Thermal System Insulation
[4]**Condition**:	Good, Fair, or Poor		
[5]**PFD:**	Potential for Disturbance due to Renovation or Demolition: Low or High		
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HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
G	**Type:**	Fire door	Fire doors at ends of hallways, stairwell doors	NA	II	Misc	Good	High	G-01		3rd floor, south stairwell fire door		ND
	Texture:	Hard exterior, powdery interior							G-02		3rd floor, north stairwell fire door		ND
	Color:	White interior											
	Size:												
	Other:												
H	**Type:**	Pinhole ceiling tile with mastic pucks	Ceilings in select classrooms and closet spaces	NA	F	Misc	Fair	High	H-01		Room 303		ND
	Texture:	Smooth							H-02		Room 303		ND
	Color:	White											
	Size:	12"x12"											
	Other:												
I	**Type:**	Floor tile and mastic	Floors in basement room 001	NA	I	Misc	Fair	High	I-01		Storage room 001		ND
	Texture:	Smooth							I-02		Storage room 001		ND
	Color:	Beige											
	Size:	12"x12"											
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

Quantities are approximate and should not be used for cost estimates or bidding purposes.

	ND = None Detected	NA = Not Applicable	HA = Homogenous Area
[1]**Quantity**:	SF = Square Feet	LF = Linear Feet	CF = Cubic Feet
[2]**Category**:	F = Friable	I = Category I, Non-Friable	II = Category II, Non-Friable
[3]**Type**:	Misc = Miscellaneous	Sur = Surfacing	TSI = Thermal System Insulation
[4]**Condition**:	Good, Fair, or Poor		
[5]**PFD:**	Potential for Disturbance due to Renovation or Demolition: Low or High		
[6]**Sample Location**:	Refer to attached floor plan(s) / field drawing(s) for specific sample locations.		

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HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
J	**Type:**	Floor tile and mastic	Floors in basement room 001	NA	I	Misc	Fair	High	J-01		Storage room 001		ND
	Texture:	Smooth							J-02		Storage room 001		ND
	Color:	Red											
	Size:	12"x12"											
	Other:												
K	**Type:**	Window caulk	Surrounding interior side of windows in basement	NA	II	Misc	Poor	High	K-01		Janitor closet, room 006		ND
	Texture:	Rough, dry							K-02		Janitor closet, room 006		ND
	Color:	White/gray											
	Size:												
	Other:												
L	**Type:**	Window glazing putty	On windows in basement	NA	II	Misc	Poor	High	L-01		Janitor closet, room 006		ND
	Texture:	Rough, dry							L-02		Janitor closet, room 006		ND
	Color:	Pink											
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

Quantities are approximate and should not be used for cost estimates or bidding purposes.

ND = None Detected NA = Not Applicable HA = Homogenous Area

[1]**Quantity**: SF = Square Feet LF = Linear Feet CF = Cubic Feet

[2]**Category**: F = Friable I = Category I, Non-Friable II = Category II, Non-Friable

[3]**Type**: Misc = Miscellaneous Sur = Surfacing TSI = Thermal System Insulation

[4]**Condition**: Good, Fair, or Poor

[5]**PFD**: Potential for Disturbance due to Renovation or Demolition: Low or High

[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
M	**Type:**	Tile and grout	Basement bathroom	NA	II	Misc	Good	High	M-01		Basement bathroom		ND
	Texture:	Smooth							M-02		Basement bathroom		ND
	Color:	Gray											
	Size:	4"x4"											
	Other:												
N	**Type:**	Tile and grout	Stairwell landings and under rubber stair treads	NA	II	Misc	Good	High			North stairwell, 3rd floor landing		ND
	Texture:	Smooth									North stairwell, 2nd floor landing		ND
	Color:	Gray											
	Size:	1"x1"											
	Other:												
O	**Type:**	Vapor barrier/waterproofing	Under plywood subfloor in select areas	NA	II	Misc	Good	High	O-01		Room 309		ND
	Texture:	Hard							O-02		Room 309		ND
	Color:	Black/gray											
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

Quantities are approximate and should not be used for cost estimates or bidding purposes.

ND = None Detected NA = Not Applicable HA = Homogenous Area

[1]**Quantity**: SF = Square Feet LF = Linear Feet CF = Cubic Feet

[2]**Category**: F = Friable I = Category I, Non-Friable II = Category II, Non-Friable

[3]**Type**: Misc = Miscellaneous Sur = Surfacing TSI = Thermal System Insulation

[4]**Condition**: Good, Fair, or Poor

[5]**PFD**: Potential for Disturbance due to Renovation or Demolition: Low or High

[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
P	**Type:**	Mastic/sealant on plywood subfloor	On top of/in between plywood subfloor layers	NA	II	Misc	Good	High	P-01		Room 312		ND
	Texture:	Hard							P-02				ND
	Color:	Black											
	Size:												
	Other:												
Q	**Type:**	Gypsum board	Transom panel above doors	NA	II	Misc	Good	High	Q-01		Above door to room 317		ND
	Texture:	Smooth							Q-02		Above door to room 313		ND
	Color:	White											
	Size:												
	Other:												
R	**Type:**	Plaster textured finish	Below chair rail in classrooms	NA	II	Sur / Misc	Good	High	R-01		Room 317, north wall		ND
	Texture:	Rough							R-02		Room 317, east wall		ND
	Color:	White/cream							R-03		Room 301, north wall		ND
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

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[4]**Condition**: Good, Fair, or Poor

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SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity	(Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
S	**Type:**	Foundation waterproofing	Crawlspace, foundation wall, southwest corner of crawlspace	NA	SF	II	Sur / Misc	Fair	High	S-01		Southwest corner of crawlspace		ND
	Texture:	Rough								S-02		Southwest corner of crawlspace		ND
	Color:	Black												
	Size:													
	Other:	Only visible in southwest corner of crawlspace												
T	**Type:**	Air cell pipe insulation	Large 8" steam line running from south crawlspace wall to north end of crawlspace	310	LF	F	TSI	Poor	High	T-01		East section of crawlspace	Insulation	65% Chrysotile
	Texture:	Corrugated											Cement	ND
	Color:	White								T-02		East section of crawlspace		Positive stop
	Size:													
	Other:	Material is falling apart, contaminating the soil below the pipe run												
U	**Type:**	Hard elbow on air cell insulation	Elbows on air cell insulated pipe	60		F	TSI	Poor	High	U-01		East section of crawlspace		70% Chrysotile
	Texture:	Hard		fittings						U-01		East section of crawlspace		Positive stop
	Color:	White												
	Size:													
	Other:													

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

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[5]**PFD**: Potential for Disturbance due to Renovation or Demolition: Low or High

[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD	Sample Information: Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
V	**Type:**	Hard elbow pipe insulation	Hard elbows on pipe coming from electrical/mechanical room in basement	NA	F	TSI	Fair	High	V-01		Basement room 001		ND
	Texture:	Hard							V-02		Basement room 001		ND
	Color:	White											
	Size:												
	Other:												
W	**Type:**	Hardwood floor underlayment	Under hardwood floors throughout each classroom and office space; hardwood floors are either the visible flooring layer, or under floor tile, or another type of flooring	NA	F	Misc	Fair	High	W-01		Room 317		ND
	Texture:	Soft, fibrous							W-02		Room 313		ND
	Color:	Gray/black											
	Size:												
	Other:												
X	**Type:**	Firestop	Penetrations in closet spaces	NA	II	Misc	Fair	High	X-01		First floor storage room next to mechanical 102		ND
	Texture:	Pliable							X-02		First floor storage room next to mechanical 102		ND
	Color:	Red											
	Size:												
	Other:												

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

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[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

SUMMARY OF ASBESTOS SAMPLING

General Information

Project Name:	UNC CH - Bingham Hall	**Inspector:**	Colby Paine	**Accreditation / License Number:**	13238	**State:**	North Carolina
S&ME Project Number:	218984	**Description of Structure:**	Multi-story academic building constructed in 1929				
Date of Assessment:	2/23/2022 & 3/3/2022						

HA	Material Description		Material Location	[1]Quantity (Units)	[2]Cat	[3]Type	[4]Cond	[5]PFD
Y	**Type:**	Window caulk	Exterior side of windows	195	II	Misc	Poor	High
	Texture:	Rough, hard		windows				
	Color:	White/gray						
	Size:							
	Other:							
Z	**Type:**	Window glazing putty	Exterior side of windows	195	II	Misc	Poor	High
	Texture:	Rough		Windows				
	Color:	White						
	Size:							
	Other:							
	Type:							
	Texture:							
	Color:							
	Size:							
	Other:							

Sample Information				
Sample Number	Building Floor	[6]Location	Layer	Percent / Type Asbestos
Y-01		North face of building, east window		2% Chrysotile
Y-02		North face of building, west window		Positive stop
Z-01		North face of building, east window		ND
Z-02		North face of building, west window		ND

Notes

Minimum Sampling Requirements		
Thermal System Insulation	**Surfacing Materials**	**Miscellaneous Materials**
≥ 3 Samples	< 1,000 SF = 3 Samples	≥ 2 Samples (EPA)
Patch < 6 LF = 1 Sample (EPA)	1,000 SF – 5,000 SF = 5 Samples	≥ 3 Samples (SC)
Patch < 6 LF = 3 Samples (SC)	> 5,000 SF = 7 Samples	

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[6]**Sample Location**: Refer to attached floor plan(s) / field drawing(s) for specific sample locations.

UNC-CH Health & Safety Office
212 Finley Golf Course Rd.
962-5507

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Date	Description/Location	Laboratory Analysis
88-B-224	11-88	Auditorium room# 203, floor tiles (off-white color)	No asbestos identified <1%
88-B-225	11-88	Classroom #308, floor tiles (yellow color)	No asbestos identified <1%
88-B-226	11-88	Basement, ME room, pipe insulation	50-60% chrysotile
88-B-227	11-88	Basement, ME room joint insulation	40-50% chrysotile
88-B-228	11-88	Ground floor stairwell door (white powder inside the door)	No asbestos identified <1%
95-AB-017	3-95	Vinyl floor tiles (9"x9") beige color, room #115 (under carpet)	<1% chrysotile asbestos in mastic only
95-AB-018	3-95	Vinyl floor tiles (9"x9") beige color, room #114 (under carpet)	2% chrysotile asbestos in both tiles and mastic
95-AB-019	3-95	Vinyl floor tiles (9"x9") beige color, room #113 (under carpet)	2% chrysotile asbestos in tiles and 5% asbestos in mastic
95-AB-020	3-95	Vinyl floor tiles (12"x12") beige color, room #203/202	2% chrysotile asbestos in tiles
95AB344	8/95	Vinyl floor tiles (12"x12") beige color, room #201	2% chrysotile asbestos in tiles and mastic
95AB345	8/95	Vinyl floor tiles (12"x12") beige color, room #201	2% chrysotile asbestos in tiles and mastic
95AB346	8/95	Vinyl floor tiles (12"x12") beige color, room #201	2% chrysotile asbestos in tiles and mastic
95AB607	12/95	MM, acoustical ceiling tile, white 12”x12”, glued on ceiling in room 203, auditorium	no asbestos detected
95AB608	12/95	MM, mastic, for acoustical ceiling tile, in room 203, auditorium	no asbestos detected
96AB378	6/96	SM, white plaster w/tan paint from 1st floor north entrance	no asbestos detected

UNC-CH Health & Safety Office

*NAD=No asbestos detected; SM=Surfacing Material; MM=Miscellaneous Material; TSI=Thermal System Insulation

212 Finley Golf Course Rd.
962-5507

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Date	Description/Location	Laboratory Analysis
96AB379	6/96	SM, white plaster w/tan paint from 1st floor north entrance	no asbestos detected
96AB380	6/96	SM, white plaster w/tan paint from 1st floor north entrance	no asbestos detected
96AB381	6/96	SM, white plaster w/tan paint from 3rd floor north end classroom	no asbestos detected
96AB382	6/96	SM, white plaster w/tan paint from 3rd floor north end classroom	no asbestos detected
96AB383	6/96	SM, white plaster w/tan paint from 3rd floor north end classroom	no asbestos detected
96AB686	9/96	MM, Vinyl floor tiles (12"x12") brown/beige, room 101	4% chrysotile asbestos in tiles and mastic
96AB687	9/96	MM, Vinyl floor tiles (12"x12") brown/beige, room 101	5% chrysotile asbestos in tiles and mastic
96AB688	9/96	MM, Vinyl floor tiles (12"x12") brown/beige, room 101	5% chrysotile asbestos in tiles and mastic
96AB689	9/96	MM, black mastic for tiles in room 101	5% chrysotile asbestos in tiles and mastic
96AB850	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 302	<1% chrysotile asbestos
96AB851	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 302	<1% chrysotile asbestos
96AB852	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 302	<1% chrysotile asbestos
96AB853	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 317	no asbestos detected
96AB854	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 317	no asbestos detected
96AB855	12/96	MM, Vinyl floor tiles (12"x12") beige/white in room 317	no asbestos detected

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962-5507

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Date	Description/Location	Laboratory Analysis
97AB172	2/97	MM, Vinyl floor tiles (12"x12") white in room 217	<1% chrysotile in tile & 5% in mastic
97AB173	2/97	MM, Vinyl floor tiles (12"x12") white in room 217	<1% chrysotile in tile & 5% in mastic
97AB174	2/97	MM, Vinyl floor tiles (12"x12") white in room 217	<1% chrysotile in tile & 5% in mastic
97AB175	2/97	MM, Vinyl floor tiles (12"x12") white in room 208	<1% chrysotile in tile & 5% in mastic
97AB176	2/97	MM, Vinyl floor tiles (12"x12") white in room 208	<1% chrysotile in tile & 5% in mastic
97AB177	2/97	MM, Vinyl floor tiles (12"x12") white in room 208	<1% chrysotile in tile & 5% in mastic
97AB178	2/97	MM, Vinyl floor tiles (12"x12") white in room 103	<1% chrysotile in tile & 5% in mastic
97AB179	2/97	MM, Vinyl floor tiles (12"x12") white in room 103	<1% chrysotile in tile & 5% in mastic
97AB180	2/97	MM, Vinyl floor tiles (12"x12") white in room 108	<1% chrysotile in tile & 5% in mastic
97AB181	2/97	MM, Vinyl floor tiles (12"x12") white in room 108	<1% chrysotile in tile & 5% in mastic
97AB182	2/97	MM, Vinyl floor tiles (12"x12") white in room 309	<1% chrysotile in tile & 2% in mastic
97AB183	2/97	MM, Vinyl floor tiles (12"x12") white in room 309	<1% chrysotile in tile & 2% in mastic
97AB184	2/97	MM, Vinyl floor tiles (12"x12") white in room 309	<1% chrysotile in tile & 2% in mastic
97AB185	2/97	MM, Vinyl floor tiles (12"x12") white in room 306	<1% chrysotile in tile & 2% in mastic
97AB186	2/97	MM, Vinyl floor tiles (12"x12") white in room 306	<1% chrysotile in tile & 2% in mastic
97AB187	2/97	MM, Vinyl floor tiles (12"x12") white in room 301	<1% chrysotile in tile & 2% in mastic

UNC-CH Health & Safety Office
212 Finley Golf Course Rd.
962-5507

*NAD=No asbestos detected; SM=Surfacing Material; MM=Miscellaneous Material; TSI=Thermal System Insulation

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Date	Description/Location	Laboratory Analysis
97AB188	2/97	MM, Vinyl floor tiles (12"x12") white in room 301	<1% chrysotile in tile & 2% in mastic
97AB189	2/97	MM, brown mastic for ceiling tiles in room 301	no asbestos detected
97AB190	2/97	MM, brown mastic for ceiling tiles in room 301	no asbestos detected
97AB191	2/97	MM, brown mastic for ceiling tiles in room 301	no asbestos detected
97AB192	2/97	MM, 12”x12” ceiling tiles in room 301	no asbestos detected
97AB193	2/97	MM, 12”x12” ceiling tiles in room 301	no asbestos detected
97AB194	2/97	MM, 12”x12” ceiling tiles in room 301	no asbestos detected
97AB539	6/97	TSI, white insulation from right side pipe in crawl space on south entrance	70% chrysotile asbestos detected
97AB540	6/97	TSI, white insulation with black paint from right side pipe in crawl space on south entrance	30% chrysotile asbestos detected
97AB541	6/97	TSI, white paper insulation from right side pipe in crawl space on south entrance	70% chrysotile asbestos detected
97AB542	6/97	TSI, white paper insulation from left side pipe in crawl space on south entrance	70% chrysotile asbestos detected
97AB543	6/97	TSI, white insulation with black paint from left side pipe in crawl space on south entrance	30% chrysotile asbestos detected
97AB544	6/97	TSI, white insulation with black paint from left side pipe in crawl space on south entrance	30% chrysotile asbestos detected

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UNC-CH Health & Safety Office
1120 Estes Drive Extension
962-5507

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Lab ID #	Date	Description/Location	Laboratory Analysis
00050679	290700285-0001	1/12/07	MM, Carpet glue located in Room 02. The color of the glue was light brown. HA#1	NAD
00050680	290700285-0002	1/12/07	MM, Carpet glue located in Room 02. The color of the glue was light brown. HA#1	NAD
00050681	290700285-0003	1/12/07	TSI, Fiberglass jacket material located on a steam line in Room 02. The material is in good condition. HA#2	NAD
00050682	290700285-0004	1/12/07	TSI, Fiberglass jacket material located on a steam line in Room 02. The material is in good condition. HA#2	NAD
00050683	290700285-0005	1/12/07	MM, Baseboard mastic located in Room 02. The carpet and baseboards are being replaced. New materials should not contain asbestos. HA#3	NAD
00050684	290700285-0006	1/12/07	MM, Baseboard mastic located in Room 02. The carpet and baseboards are being replaced. New materials should not contain asbestos. HA#3	NAD
00050716	290700484-0001 and 0001A	1/26/07	MM, 9" beige floor tile with blue and rust streaks with black mastic. The sample was collected near the entrance to Room 303. HA#4	NAD (tile) NAD (mastic)
00050717	290700484-0002 and 0002A	1/26/07	MM, 9" beige floor tile with blue and rust streaks with black mastic. The sample was collected towards the middle of Room 303. HA#4	NAD (tile) NAD (mastic)
	Asbestos containing floor tile and mastic was removed from Rooms 114, 115 and 117 on February 8-11 2008, by Bar Lyn. Prescott Environmenal provided the project oversight and air monitoring.			
00060152	290705520-0001	11/5/07	MM, Gray stair tread with a speckled design located on the 1st floor section of the north stairwell. The material is delaminating and the material is being replaced.	NAD
00060153	290705520-0002	11/5/07	MM, Gray stair tread with a speckled design located on the 2nd floor section of the north stairwell. The material is delaminating and the material is being replaced.	NAD

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UNC-CH Health & Safety Office
1120 Estes Drive Extension
962-5507

Asbestos Sample Log
Bulk Samples

Building Name: Bingham Hall

Sample ID#	Lab ID #	Date	Description/Location	Laboratory Analysis
00060154	290705520-0003	11/5/07	MM, Gray stair tread with a speckled design located on the 2nd floor section of the south stairwell. The material is delaminating and the material is being replaced.	NAD
00060155	290705520-0004	11/5/07	MM, Gray stair tread with a speckled design located on the 1st floor section of the south stairwell. The material is delaminating and the material is being replaced.	NAD

*NAD=No asbestos detected; SM=Surfacing Material; MM=Miscellaneous Material; TSI=Thermal System Insulation

TABLE 1

BULK ASBESTOS SAMPLE ANALYSIS RESULTS

Bingham Hall, UNC-CH
Main Quad
Chapel Hill, NC 27599

Sample I.D.	Date/Time	Material Description	Material Location	Asbestos Type	Asbestos Percent
BH-1	4/7/06- 4:07	Hard Plaster Ceiling	Men's Bathroom Basement	NAD[1]	0%
BH-2	4/7/06- 4:11	Hard Plaster Ceiling	Hallway - Basement	NAD	0%
BH-3	4/7/06- 4:12	Hard Plaster Ceiling	Stairwell 1- Basement	NAD	0%
BH-4	4/7/06- 4:15	Hard Plaster Ceiling	Stairwell 1- 1st Floor	NAD	0%
BH-5	4/7/06- 4:19	Hard Plaster Ceiling	Hallway - 1st Floor	NAD	0%
BH-6	4/7/06- 4:22	Hard Plaster Ceiling	Stairwell 2- 1st Floor	NAD	0%
BH-7	4/7/06- 4:27	Hard Plaster Ceiling	Stairwell 2- 2nd Floor	NAD	0%
BH-8	4/7/06- 4:30	Hard Plaster Ceiling	Hallway - 2nd Floor	NAD	0%
BH-9	4/7/06- 4:33	12" X 12" Ceiling Tile/glue pucks	Classroom 203 2nd Floor	NAD	0%
BH-10	4/7/06- 4:37	Plaster Wall Material	Classroom 203 2nd Floor	NAD	0%
BH-11	4/7/06- 4:41	Plaster Wall Material	Classroom 217 2nd Floor	NAD	0%
BH-12	4/7/06- 4:43	2' X 2' Ceiling Tile	Classroom 217 2nd Floor	NAD	0%
BH-13	4/7/06- 4:45	Hard Plaster Ceiling	Women's Bathroom 2nd Floor	NAD	0%
BH-14	4/7/06- 4:50	Plaster Wall Material	Classroom 208 2nd Floor	NAD	0%
BH-15	4/7/06 - 4:52	2' X 2' Ceiling Tile	Classroom 208 2nd Floor	NAD	0%
BH-16	4/7/06 - 4:55	Plaster Wall Material	Classroom 301/302 3rd Floor	NAD	0%
BH-17	4/7/06 - 4:57	2' X 2' Ceiling Tile	Classroom 301/302 3rd Floor	NAD	0%
BH-18	4/7/06 - 4:59	Hard Ceiling Plaster	Hallway - 3rd Floor	NAD	0%
BH -19	4/7/06 - 5:02	Hard Ceiling Plaster	Men's Bathroom 3rd Floor	NAD	0%

[1]NAD - No Asbestos Detected

The report was generated by Prescott Environmental on 4/10/06. Doug Prescott Inspector Number 10673

*NAD=No asbestos detected; SM=Surfacing Material; MM=Miscellaneous Material; TSI=Thermal System Insulation

TABLE 1 (CONTINUED)
BULK ASBESTOS SAMPLE ANALYSIS RESULTS
Bingham Hall, UNC-CH
Cameron Avenue
Chapel Hill, NC 27599

Sample I.D.	Date/Time	Material Description	Material Location	Asbestos Type	Asbestos Percent
BH-20	4/7/06- 5:05	Plaster Wall Material	Classroom 306 3rd Floor	NAD[1]	0%
BH-21	4/7/06- 5:08	Plaster Wall Material	Classroom 309 3rd Floor	NAD	0%
BH-22	4/7/06- 5:12	Plaster Wall Material	Classroom 317 3rd Floor	NAD	0%
BH-23	4/7/06- 5:14	2' X 2' Ceiling Tile	Classroom 317 3rd Floor	NAD	0%
BH-24	4/7/06- 5:18	Ceiling Plaster Material	2nd Stairwell - 3rd Floor Level	NAD	0%
BH-25	4/7/06- 5:23	Plaster Wall Material	Classroom 103 1st Floor	NAD	0%
BH-26	4/7/06- 5:24	2' X 2' Ceiling Tile	Classroom 103 1st Floor	NAD	0%
BH-27	4/7/06- 5:25	12" X 12" Ceiling Tile/Glue "Pucks"	Classroom 103 1st Floor	NAD	0%
BH-28	4/7/06- 6:15	Plaster Ceiling Material	Classroom 101 1st Floor	NAD	0%
BH-29	4/7/06- 6:18	2' X 2' Ceiling Tile	Classroom 101 1st Floor	NAD	0%
BH-30	4/7/06- 6:19	12" X 12" Ceiling Tile/Glue "Pucks"	Classroom 101 2nd Floor	NAD	0%
BH-31	4/7/06- 6:34	Plaster Wall Material	Classroom 108 1st Floor	NAD	0%
BH-32	4/7/06- 6:35	2' X 2' Ceiling Tile	Classroom 108 1st Floor	NAD	0%
BH-33	4/7/06- 6:36	Hard Plaster Ceiling	Classroom 108 1st Floor	NAD	0%

[1]NAD - No Asbestos Detected

*NAD=No asbestos detected; SM=Surfacing Material; MM=Miscellaneous Material; TSI=Thermal System Insulation

Date of the Inspections:	4/27/2010, 12/31/2011. 8/31/2010, 9/3/2010 and 2/15/2011	Inspectors:	Stephen Cost Janet Phillips

HA #	Asbestos Sample ID	Material Type	Material Description	Floor	Room	Comments	Asbestos Type	Lab ID	Source Sample
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	350A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	315	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	310	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	314A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	325A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	306A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	375	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	375A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	325B	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	311	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	300	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	325	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	350	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	316	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	313	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	314	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	215	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	225	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	210	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	200	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	209	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	201A	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	201	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	200A	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	212	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	200B	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	211	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	201B	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	225A	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	201C	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	214	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	205	Visual Sample Only			V007_282B
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	225B	Visual Sample Only			V007_282B

Date of the	4/27/2010, 12/31/2011. 8/31/2010, 9/3/2010 and 2/15/2011	Inspectors:	Stephen Cost Janet Phillips

HA #	Asbestos Sample ID	Material Type	Material Description	Floor	Room	Comments	Asbestos Type	Lab ID	Source Sample
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	111	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	115	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	150	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	130	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	112	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	106	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	150A	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	104	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	114	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	110	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	109	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	115A	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	113	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	100A	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	105	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	140	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	117	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	120	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	116	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	116A	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	100	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	2	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	99	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	3A	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	1B	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	1A	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	3	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	BT	1	Visual Sample Only			V007_282
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	03	300A	Visual Sample Only			V007_282C
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	01	103A	Visual Sample Only			V007_282A
282	C-201004	Ceiling - Plaster	Smooth Hard Plaster	02	203A	Visual Sample Only			V007_282B
282	V007_282	Ceiling - Plaster	Smooth Hard Plaster	BT	1	Visual Sample Only			
282	V007_282	Ceiling - Plaster	Smooth Hard Plaster	01	100B	Visual Sample Only			
282	V007_282	Ceiling - Plaster	Smooth Hard Plaster	02	200C	Visual Sample Only			
282	V007_282	Ceiling - Plaster	Smooth Hard Plaster	03	300B	Visual Sample Only			

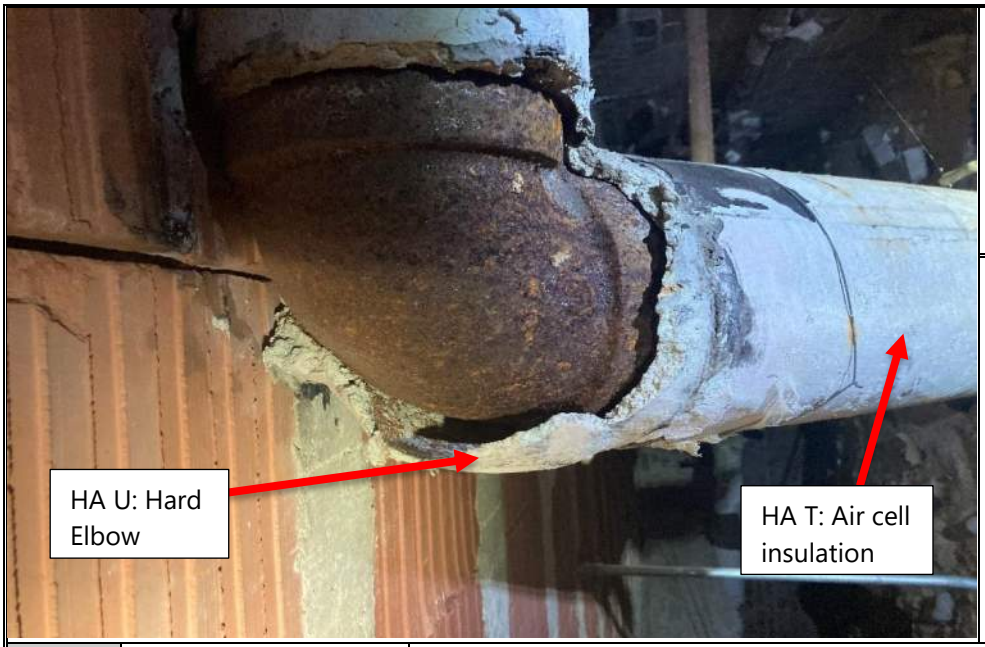
Date of the	4/27/2010, 12/31/2011. 8/31/2010, 9/3/2010 and 2/15/2011	Inspectors:	Stephen Cost Janet Phillips

HA #	Asbestos Sample ID	Material Type	Material Description	Floor	Room	Comments	Asbestos Type	Lab ID	Source Sample
284	V007_284	Ceiling - Other	Elevator	BT	99	Visual Sample Only			
284	V007_284	Ceiling - Other	Elevator	01	199	Visual Sample Only			
284	V007_284	Ceiling - Other	Elevator	02	299	Visual Sample Only			
284	V007_284	Ceiling - Other	Elevator	03	399	Visual Sample Only			
285	F007_285	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	02	217	Reference Sample to Place Homogeneous Area on Floor. Copy Sample Data from Other Samples of this Material.			
285	SME1-363	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	01	199A		No Asbestos Detected	10-8546	
285	C-201004	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	03	309				SME1-370
285	C-201004	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	03	301				SME1-370
285	C-201004	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	03	399A				SME1-370
285	C-201004	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	02	204	Reference Sample to Place Homogeneous Area on Floor. Copy Sample Data from Other Samples of this Material.			F007_285

Date of the Inspections:	4/27/2010, 12/31/2011. 8/31/2010, 9/3/2010 and 2/15/2011					Inspectors:	Stephen Cost Janet Phillips		
HA #	Asbestos Sample ID	Material Type	Material Description	Floor	Room	Comments	Asbestos Type	Lab ID	Source Sample
285	C-2010042	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	01	108				SME1-363
285	C-2010042	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	01	101				SME1-363
285	C-2010042	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	01	103				SME1-363
285	SME1-370	2 X 2 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	03	317		No Asbestos Detected	10-8553	
287	C-2010042	Ceiling Tile - Splined	1'x1'; Perforated spline ceiling tile	02	203	Visual Sample Only			V007_287A
287	V007_287	Ceiling Tile - Splined	1'x1'; Perforated spline ceiling tile	01	101A	Visual Sample Only			
287	V007_287	Ceiling Tile - Splined	1'x1'; Perforated spline ceiling tile	02	206	Visual Sample Only			
287	V007_287	Ceiling Tile - Splined	1'x1'; Perforated spline ceiling tile	03	303	Visual Sample Only			
288	SME1-366	2 X 2 Ceiling Tile	Thin Fissures, Pocks and Pinholes	03	304		No Asbestos Detected	10-8549	
288	SME1-367	2 X 2 Ceiling Tile	Thin Fissures, Pocks and Pinholes	03	304		No Asbestos Detected	10-8550	
289	SME1-368	2 X 2 Ceiling Tile	Pocks and Pinholes in Random Pattern	03	306		No Asbestos Detected	10-8551	
289	SME1-369	2 X 2 Ceiling Tile	Pocks and Pinholes in Random Pattern	03	306		No Asbestos Detected	10-8552	
290	SME1-364	2 X 4 Ceiling Tile	Jagged Fissures and Pinholes in Random Directions	03	308		No Asbestos Detected	10-8547	
290	SME1-365	2 X 4 Ceiling Tile	Jagged Fissures and Pinholes in Random	03	312		No Asbestos Detected	10-8548	

Date of the Inspections:	4/27/2010, 12/31/2011. 8/31/2010, 9/3/2010 and 2/15/2011			Inspectors:	Stephen Cost Janet Phillips			
HA #	**Asbestos Sample ID**	**Material Type**	**Material Description**	**Floor**	**Room**	**Comments**	**Asbestos Type**	**Lab ID**	**Source Sample**
897	20081261	Floor - Vinyl Composite Tile	12 inch cream floor tile	03	308	and leveling compound tested negative for this room.	No Asbestos Detected	291005656-0001	
897	20081262	Floor - Vinyl Composite Tile	12 inch cream floor tile	03	308	and leveling compound tested negative for this room.	No Asbestos Detected	291005656-0002	
970	00060048	Floor - Vinyl Composite Tile	12 inch bown speckled floor tile and yellow mastic	03	308	The floor tile and mastic tested negative for asbestos.	No Asbestos Detected	291101082-0001 and 0001A	
971	00060049	Exterior Wall Surfacing Material	Exterior water proofing material	03	308	Exterior water proofing behind the plaster wall.	No Asbestos Detected	291101082-0002	
971	00060050	Exterior Wall Surfacing Material	Exterior water proofing material	03	308	Exterior water proofing behind the plaster wall.	No Asbestos Detected	291101082-0003	

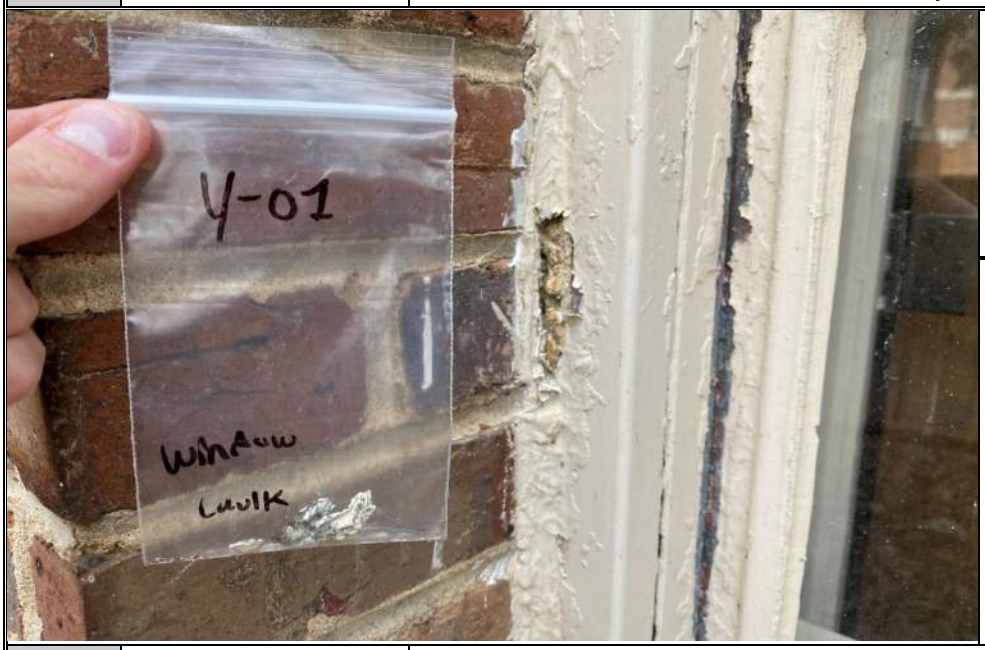
Appendix II – Photographs and Sample Location Drawings



3/3/2022

Photographer: Janet Phillips

1	**Location / Orientation**	Pipe running parallel to eastern crawlspace wall
	Remarks	HA T: Air cell pipe insulation: 65% Chrysotile HA U: Hard elbow on Air cell insulation: 70% Chrysotile



3/3/2022

Photographer: Janet Phillips

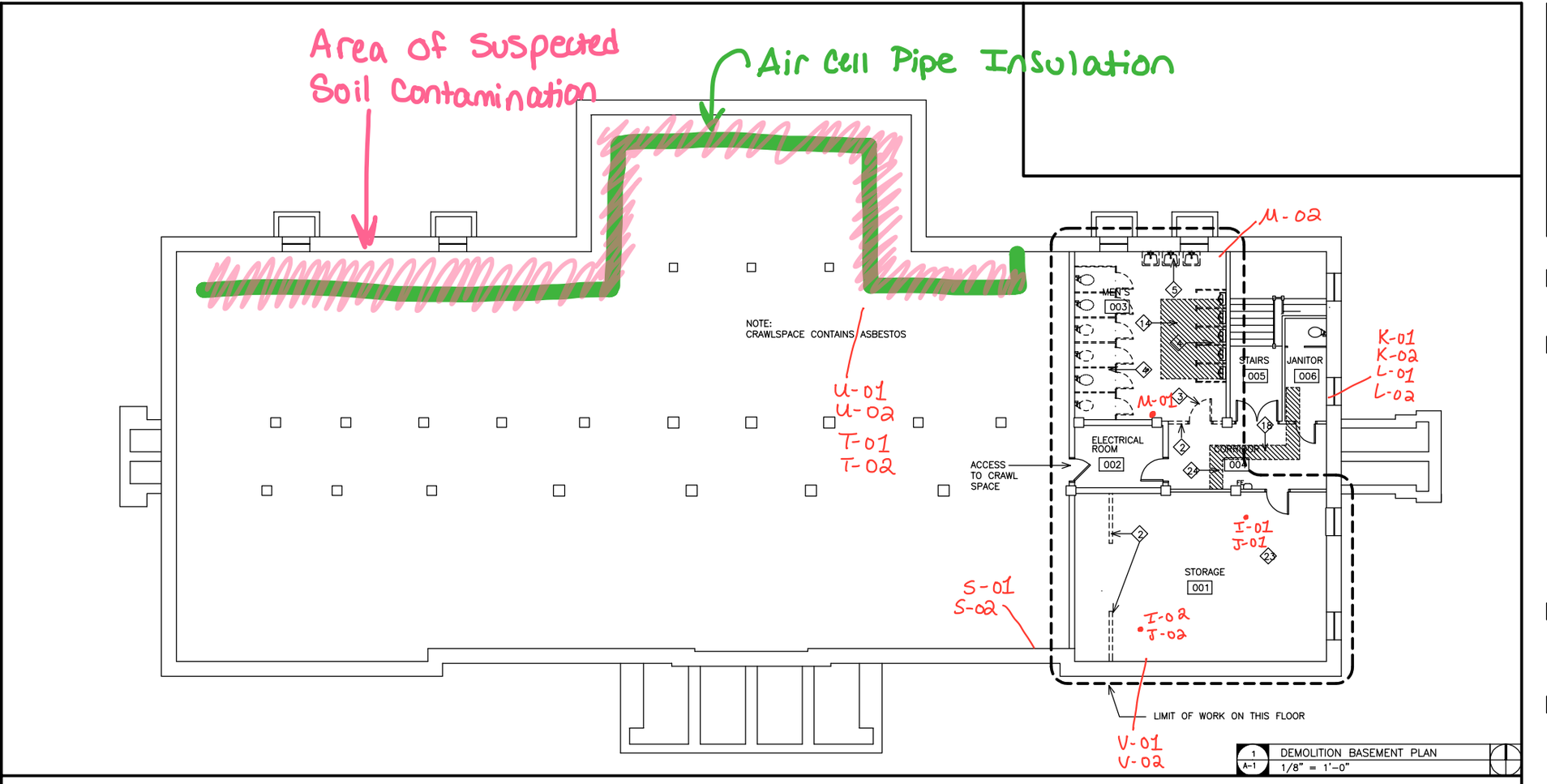
2	**Location / Orientation**	Exterior side of windows; Bingham Hall
	Remarks	HA Y: Exterior window caulk: 2% Chrysotile

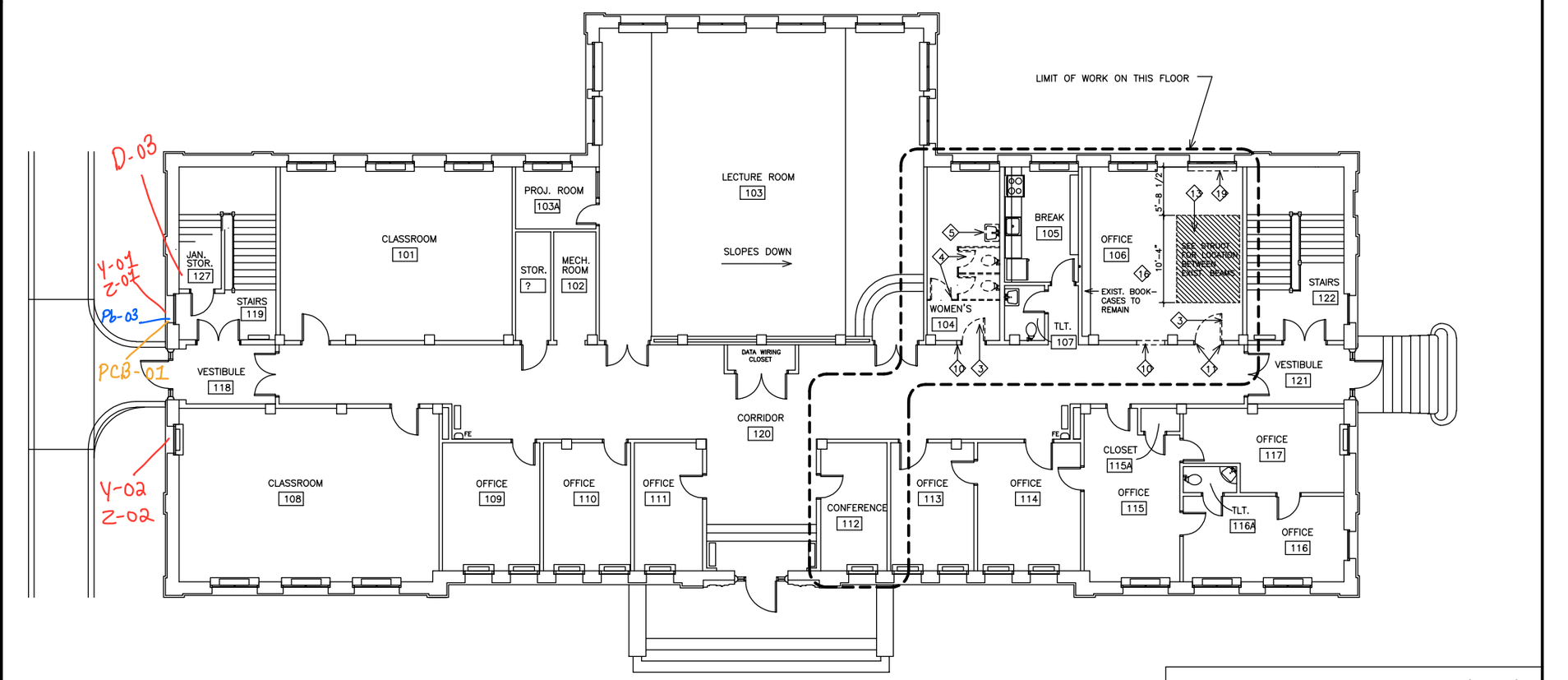
			Photographer: Janet Phillips 3/3/2022
3	**Location / Orientation**	No. 6 Dry Cell Batteries	
	Remarks	Located in the attci	
			Photographer: Janet Phillips 3/3/2022
4	**Location / Orientation**	No. 6 Dry Cell Batteries and asbestos wiring	
	Remarks	Located in the attci	

			Photographer: Janet Phillips 3/3/2022
5	**Location / Orientation**	Metal Support-Visible Mold	
	Remarks	Attic	
			Photographer: Janet Phillips 3/3/2022
6	**Location / Orientation**	Paint on metal radiator	
	Remarks	HA Y: Exterior window caulk: 2% Chrysotile	

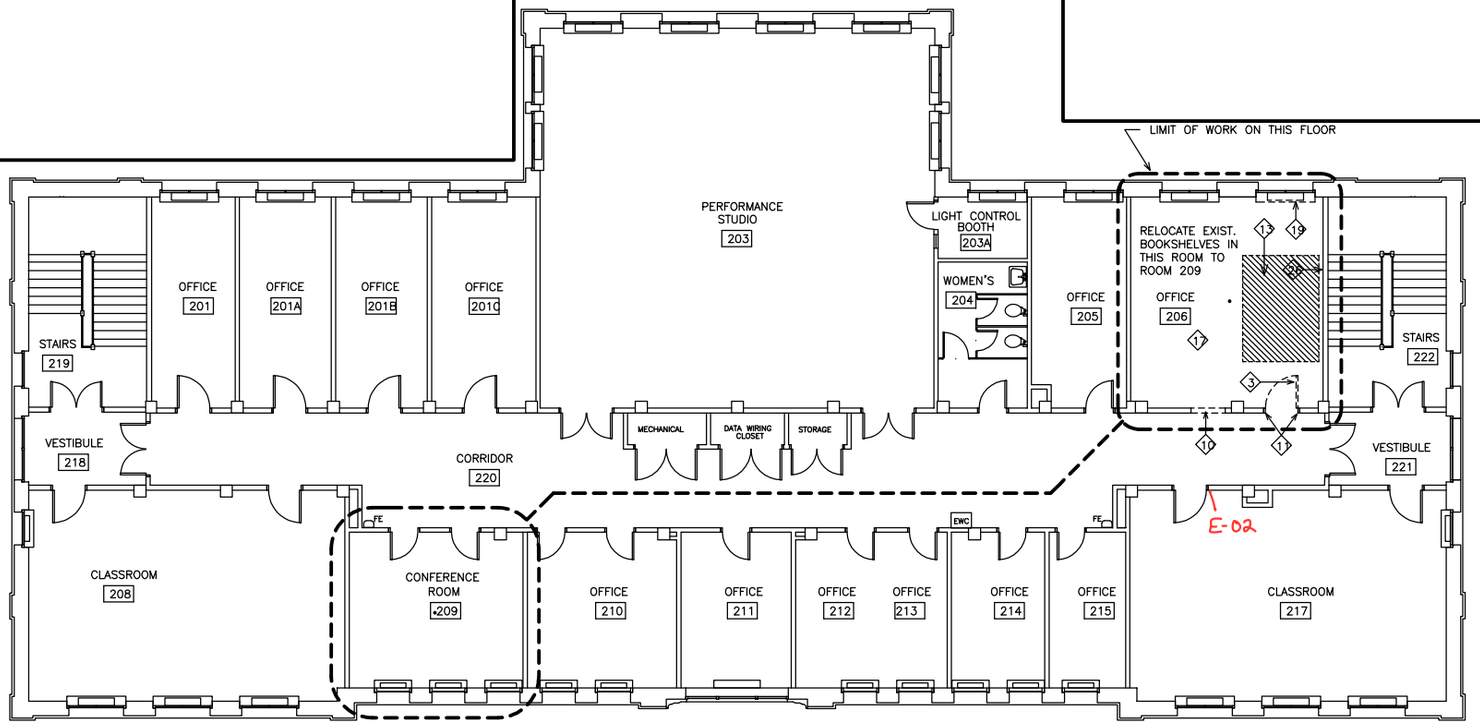
			3/3/2022 Photographer: Janet Phillips
7	**Location / Orientation**	Water proofing	
	Remarks	Crawlspace	
			3/3/2022 Photographer: Janet Phillips
8	**Location / Orientation**	Crawlspace	
	Remarks	View of crawlspace and debris	

			3/3/2022 Photographer: Janet Phillips
9	**Location / Orientation**	Damaged TSI	
	Remarks	Crawlspace	
			3/3/2022 Photographer: Janet Phillips
10	**Location / Orientation**	Surface contamination of TSI (Aircell pipe insulation)	
	Remarks	Crawlspace	

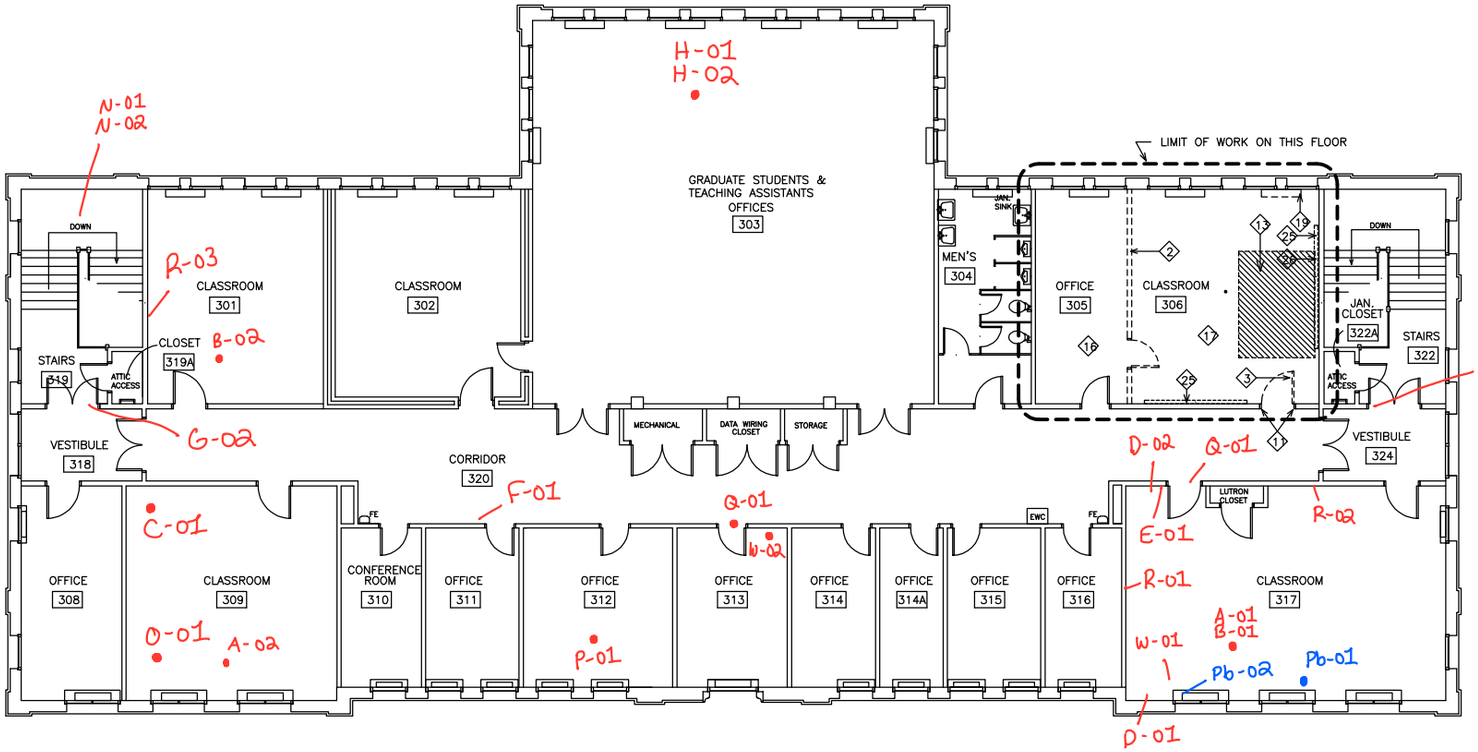




RECORD DRAWING 05/01/02



1 A-2 DEMOLITION SECOND FLOOR PLAN
1/8" = 1'-0"



RECORD DRAWING 05/01/02

2 A-2 DEMOLITION THIRD FLOOR PLAN
1/8" = 1'-0"

Appendix III – Asbestos Inspector Accreditation

NC DEPARTMENT OF
HEALTH AND
HUMAN SERVICES

K COOPER • Governor

MANDY COHEN, MD, MPH • Secretary

MARK T. BENTON • Assistant Secretary for Public Health,

Division of Public Health

October 1, 2021

Colby L Paine
5306 John Washington Rd
Browns Summit, NC 27214

Dear Mr. Paine:

Based upon the review of your accreditation application, the Health Hazards Control Unit (HHCU) has determined that you have fulfilled the requirements and are eligible for asbestos accreditation as a(n) INSPECTOR. Your assigned North Carolina accreditation number is 13238, which is reflected on your enclosed North Carolina Accreditation card. Please be sure to take this card with you to any asbestos work site where you are employed. The State requires that all persons conducting asbestos abatement or asbestos management activities be accredited and have their identification card on site.

Your North Carolina Inspector accreditation will expire on SEPTEMBER 30, 2022. It is NOT the policy of the HHCU to issue renewal notices. If you wish to continue working as a(n) Inspector after this expiration date, you must successfully complete the required training and submit a completed application to this office prior to September 30, 2022. If you should continue to perform asbestos management activities as a(n) Inspector without a valid North Carolina accreditation, you will be in violation of State regulations and may be cited for noncompliance.

Sincerely,

Ed Norman
Program Manager
Health Hazards Control Unit

Colby L Paine
5306 John Washington Rd
Browns Summit, NC 27214

133937

North Carolina
Asbestos Accreditation

EXPIRATION			
09-30-2022			
DOB	SEX	HT	WT
07-26-1997	M	6'1"	158
CLASS		#	EXP
INSPECTOR		13238	09-22

NC DEPARTMENT OF HEALTH AND HUMAN SERVICES

ROY COOPER • Governor

MANDY COHEN, MD, MPH • Secretary

MARK T. BENTON • Assistant Secretary for Public Health,

Division of Public Health

February 1, 2022

Janet K Phillips
801 Sweetwood Trace Ct
Holly Springs, NC 27540

Dear Ms. Phillips:

Based upon the review of your accreditation application, the Health Hazards Control Unit (HHCU) has determined that you have fulfilled the requirements and are eligible for asbestos accreditation as a(n) AIR MONITOR. Your assigned North Carolina accreditation number is 80751, which is reflected on your enclosed North Carolina Accreditation card. Please be sure to take this card with you to any asbestos work site where you are employed. The State requires that all persons conducting asbestos abatement or asbestos management activities be accredited and have their identification card on site.

Your North Carolina Air Monitor accreditation will expire on DECEMBER 31, 2022. It is NOT the policy of the HHCU to issue renewal notices. If you wish to continue working as a(n) Air Monitor after this expiration date, you must successfully complete the required training and submit a completed application to this office prior to December 31, 2022. If you should continue to perform asbestos management activities as a(n) Air Monitor without a valid North Carolina accreditation, you will be in violation of State regulations and may be cited for noncompliance.

Sincerely,

Ed Norman
Program Manager
Health Hazards Control Unit

Janet K Phillips
801 Sweetwood Trace Ct
Holly Springs, NC 27540

135121

North Carolina
Asbestos Accreditation

EXPIRATION			
12-31-2022			
DOB	SEX	HT	WT
11-10-1962	F	5'3"	168
CLASS		#	EXP
AIR MONITOR		80751	12-22
DESIGNER		40324	12-22
INSPECTOR		11730	09-22
MGMT PLANNER		20877	09-22

Appendix IV – Laboratory Reports

9751 Southern Pine Boulevard
Charlotte, NC 28273
704-940-1830 Fax 704-565-4929
NVLAP Lab Code 102075-0

POLARIZED LIGHT MICROSCOPY
Performed by EPA 600/R-93/116 Method

Asbestos Analysis Summary

Client Name Greensboro Office
Client Job UNC CH Bingham Hall

8646 W. Market St Suite 105
Greensboro NC 27409

Date Received 2/25/2022
Date Analyzed 3/2/2022

Job Number 218984

Lab ID:	Sample #:	Appearance	Comments	Asbestos %/Type	Non-Asbestos Fibrous %/Type	Non-Fibrous %/Type
22-2673A	A-01	TAN NONFIBROUS	TILE	ND		100 OTHER
22-2673B	A-01	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2674A	A-02	TAN NONFIBROUS	TILE	ND		100 OTHER
22-2674B	A-02	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

For heterogeneous samples easily separated into subsamples, and for layered samples, each component is analyzed separately. ND = None Detected (Asbestos Not Present In Representative Sample). RCF= (Refractory Ceramic Fiber) The results relate only to the items tested.
The sample may not be fully representative of the larger material in question. This report shall not be reproduced except in full with permission from SME, Inc. This report may not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. Although Polarized Light Microscopy (PLM/Dispersion Staining) (Method EPA 600/R-93/116) is the specified method for analysis of bulk material samples for asbestos under the EPA Asbestos Hazard Emergency Response Act, there have been reports that this method may not identify asbestos when fiber sizes are extremely small or if they are bound in a resinous material. Such materials include floor tile, mastic and asphaltic roofing. Currently, reanalysis by Transmission Electron Microscopy (TEM) to verify results of <1% or "None Detected" for these materials is recommended.

Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2675A	B-01	GREY NONFIBROUS	TILE	ND		100 OTHER
22-2675B	B-01	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2676A	B-02	GREY NONFIBROUS	TILE	ND		100 OTHER
22-2676B	B-02	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2677A	C-01	RED NONFIBROUS	TILE	ND		100 OTHER
22-2677B	C-01	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

For heterogeneous samples easily separated into subsamples, and for layered samples, each component is analyzed separately. ND = None Detected (Asbestos Not Present In Representative Sample). RCF= (Refractory Ceramic Fiber) The results relate only to the items tested.
The sample may not be fully representative of the larger material in question. This report shall not be reproduced except in full with permission from SME, Inc. This report may not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. Although Polarized Light Microscopy (PLM/Dispersion Staining) (Method EPA 600/R-93/116) is the specified method for analysis of bulk material samples for asbestos under the EPA Asbestos Hazard Emergency Response Act, there have been reports that this method may not identify asbestos when fiber sizes are extremely small or if they are bound in a resinous material. Such materials include floor tile, mastic and asphaltic roofing. Currently, reanalysis by Transmission Electron Microscopy (TEM) to verify results of <1% or "None Detected" for these materials is recommended.

Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2678A	C-02	RED NONFIBROUS	TILE	ND		100 OTHER
22-2678B	C-02	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2679A	D-01	BEIGE GRANULAR	PLASTER 1	ND		100 OTHER
22-2679B	D-01	GREY GRANULAR	PLASTER 2	ND	<1 HAIR	100 OTHER
22-2680A	D-02	BEIGE GRANULAR	PLASTER 1	ND		100 OTHER
22-2680B	D-02	GREY GRANULAR	PLASTER 2	ND	<1 HAIR	100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

For heterogeneous samples easily separated into subsamples, and for layered samples, each component is analyzed separately. ND = None Detected (Asbestos Not Present In Representative Sample). RCF= (Refractory Ceramic Fiber) The results relate only to the items tested.
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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2681A	D-03	WHITE NONFIBROUS	SKIM COAT	ND		100 OTHER
22-2681B	D-03	GREY GRANULAR	PLASTER	ND	<1 HAIR	100 OTHER
22-2682	E-01	YW/BEIGE NONFIBROUS		ND		100 OTHER
22-2683	E-02	CREAM NONFIBROUS		ND		100 OTHER
22-2684	F-01	GREY NONFIBROUS		ND		100 OTHER
22-2685	F-02	GREY NONFIBROUS		ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2686	G-01	BEIGE FIBROUS		ND	10 CELLULOSE	90 OTHER
22-2687	G-02	BEIGE FIBROUS		ND	10 CELLULOSE	90 OTHER
22-2688	H-01	BROWN NONFIBROUS		ND		100 OTHER
22-2689	H-02	BROWN NONFIBROUS		ND		100 OTHER
22-2690A	I-01	TAN NONFIBROUS	TILE	ND		100 OTHER
22-2690B	I-01	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2691A	I-02	TAN NONFIBROUS	TILE	ND		100 OTHER
22-2691B	I-02	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2692A	J-01	RED NONFIBROUS	TILE	ND		100 OTHER
22-2692B	J-01	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER
22-2693A	J-02	RED NONFIBROUS	TILE	ND		100 OTHER
22-2693B	J-02	YELLOW NONFIBROUS	MASTIC	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2694	K-01	WHITE NONFIBROUS		ND		100 OTHER
22-2695	K-02	WHITE NONFIBROUS		ND		100 OTHER
22-2696	L-01	PINK NONFIBROUS		ND		100 OTHER
22-2697	L-02	PINK NONFIBROUS		ND		100 OTHER
22-2698A	M-01	WHITE NONFIBROUS	LAYER 1	ND		100 OTHER
22-2698B	M-01	GREY NONFIBROUS	LAYER 2	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2699A	M-02	GREY NONFIBROUS	CERAMIC TILE	ND		100 OTHER
22-2699B	M-02	GREY GRANULAR	GROUT	ND		100 OTHER
22-2700A	N-01	WHITE NONFIBROUS	CERAMIC TILE	ND		100 OTHER
22-2700B	N-01	GREY NONFIBROUS	GROUT	ND		100 OTHER
22-2701A	N-02	WHITE NONFIBROUS	CERAMIC TILE	ND		100 OTHER
22-2701B	N-02	GREY NONFIBROUS	GROUT	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2702	O-01	GREY NONFIBROUS		ND		100 OTHER
22-2703	P-01	GREY /YW NONFIBROUS		ND		100 OTHER
22-2704A	Q-01	TAN/BEIGE FIBROUS	DRYWALL	ND	90 CELLULOSE 1 GLASS	9 GYPSUM
22-2704B	Q-01	WHITE PLIABLE	CAULK	ND		100 OTHER
22-2705A	Q-02	TAN/BEIGE FIBROUS	DRYWALL	ND	99 CELLULOSE <1 GLASS	1 GYPSUM
22-2705B	Q-02	WHITE PLIABLE	CAULK	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-2706	R-01	BEIGE NONFIBROUS		ND		1 PERLITE 99 OTHER
22-2707	R-02	BEIGE NONFIBROUS		ND		1 PERLITE 99 OTHER
22-2708	R-03	BEIGE NONFIBROUS		ND		1 PERLITE 99 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/02/22

Jane Wasilewski
Laboratory Manager

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BULK SAMPLE
CHAIN OF CUSTODY RECORD

(+) stop

PROJECT NO. Phase 476	PROJECT NAME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
218984	UNC CH - Bingham Hall	Colby Paine	02/24/22	12:00 PM	Fed-Ex
FACILITY		RELINQUISHED BY:	DATE	TIME	RECEIVED BY: 2/25/22 1:10 pm
36 Lenoir Drive, Chapel Hill, NC					
SAMPLER(S)	**DATE TAKEN**	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Colby Paine/Janet Phillips	2/23/2022				

SAMPLE #	HOMOGENEOUS AREA	MATERIAL TYPE	LAB NUMBER	DATE ANALYZED	ANALYSTS INITIALS	ASBESTOS +	ASBESTOS N/D	ARCHIVE NUMBER	DATE ARCH	ARCHIVER INITIALS	SPECIAL INSTRUCTIONS
A-01	A	Floor tile	22-2673								
A-02		Floor tile	74								
B-01	B	Floor tile	75								
B-02		Floor tile	76								
C-01	C	Floor tile	77								
* → C-02		Floor tile	2678								
E-01	E	Covebase and glue	82								
E-02		Covebase and glue	83								
F-01	F	Terazzo flooring	84								
F-02		Terazzo flooring	85								
G-01	G	Fire door interior	86								
G-02		Fire door interior	87								
H-01	H	Ceiling tile mastic puck	88								
H-02		Ceiling tile mastic puck	89								
I-01	I	Floor tile	90								
I-02		Floor tile	2691								

* D-01 Additional samples Received. Tm 22-2679
-02 80
-03 81

BULK SAMPLE
CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
218984	UNC CH - Bingham Hall	Colby Paine	02/24/22	12:00 PM	Fed-Ex
FACILITY		RELINQUISHED BY:	DATE	TIME	RECEIVED BY: 2/25/22
36 Lenoir Drive, Chapel Hill, NC					
SAMPLER(S)	**DATE TAKEN**	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Colby Paine/Janet Phillips	2/23/2022				

SAMPLE #	HOMOGENEOUS AREA	MATERIAL TYPE	LAB NUMBER	DATE ANALYZED	ANALYSTS INITIALS	ASBESTOS +	ASBESTOS N/D	ARCHIVE NUMBER	DATE ARCH	ARCHIVER INITIALS	SPECIAL INSTRUCTIONS
J-01	J	Floor tile	22-2692								
J-02		Floor tile	93								
K-01	K	window caulk	94								
K-02		window caulk	95								
L-01	L	window glazing putty	96								
L-02		window glazing putty	97								
M-01	M	Tile and grout	98								
M-02		Tile and grout	2699								
N-01	N	Tile and grout	2700								
N-02		Tile and grout	01								
O-01	O	Vapor barrier/sealant	02								
P-01	P	Vapor barrier/sealant	03								
Q-01	Q	Gypsum board	04								
Q-02		Gypsum board	05								
R-01	R	Plaster textured finish	06								
R-02		Plaster textured finish	07								
R-03		Plaster textured finish	2708								

ALL SAMPLES WILL BE DISPOSED OF NINETY DAYS AFTER ANALYSIS UNLESS OTHERWISE REQUESTED

3-5 Day TAT
Positive Stop
Do not analyze rubber cove base (if present), only glue

This document was prepared pursuant to a specific agreement to

33 samples total

9751 Southern Pine Boulevard
Charlotte, NC 28273
704-940-1830 Fax 704-565-4929
NVLAP Lab Code 102075-0

POLARIZED LIGHT MICROSCOPY
Performed by EPA 600/R-93/116 Method

Asbestos Analysis Summary

Client Name Greensboro Office
Client Job UNC CH Bingham Hall

8646 W. Market St Suite 105
Greensboro NC 27409

Date Received 3/7/2022
Date Analyzed 3/10/2022

Job Number 218984

Lab ID:	Sample #:	Appearance	Comments	Asbestos %/Type	Non-Asbestos Fibrous %/Type	Non-Fibrous %/Type
22-3082	S-01	BLACK FIBROUS		ND	5 CELLULOSE	95 OTHER
22-3083	S-02	BLACK FIBROUS		ND	5 CELLULOSE	95 OTHER
22-3084A	T-01	GREY FIBROUS	INSULATION	65 CHRYSOTILE		35 OTHER
22-3084B	T-01	GREY CEMENTITIOUS	CEMENT	ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/10/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-3086	U-01	GREY FIBROUS		70 CHRYSOTILE		30 OTHER
22-3088A	V-01	BEIGE FIBROUS	WRAP	ND	1 CELLULOSE	99 OTHER
22-3088B	V-01	GREY FIBROUS	INSULATION	ND	45 MINERAL WOOL	55 OTHER
22-3089A	V-02	BEIGE FIBROUS	WRAP	ND	20 CELLULOSE	80 OTHER
22-3089B	V-02	GREY FIBROUS	INSULATION	ND	45 MINERAL WOOL	55 OTHER
22-3090	W-01	GREY FIBROUS		ND	98 CELLULOSE 2 SYNTHETIC	

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/10/22

Jane Wasilewski
Laboratory Manager

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Job Number 218984

Lab ID:	*Sample #:*	*Appearance*	*Comments*	*Asbestos %/Type*	*Non-Asbestos Fibrous %/Type*	*Non-Fibrous %/Type*
22-3091	W-02	GREY FIBROUS		ND	98 CELLULOSE 2 SYNTHETIC	
22-3092	X-01	RED FIBROUS		ND	2 GLASS	98 OTHER
22-3093	X-02	RED FIBROUS		ND	2 GLASS	98 OTHER
22-3094	Y-01	GRY/BEIGE NONFIBROUS		2 CHRYSOTILE		98 OTHER
22-3096	Z-01	BEIGE PLIABLE		ND		100 OTHER
22-3097	Z-02	BEIGE PLIABLE		ND		100 OTHER

Analyzed by: Jane Wasilewski

Additional Comments: Issued 3/10/22

Jane Wasilewski
Laboratory Manager

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BULK SAMPLE
CHAIN OF CUSTODY RECORD

PROJECT NO.	PROJECT NAME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
218984	UNC CH - Bingham Hall	Colby Paine	03/04/22	12:00 PM	Fed-Ex
FACILITY		RELINQUISHED BY:	DATE	TIME	RECEIVED BY: 11:35 3/7/22
36 Lenoir Drive, Chapel Hill, NC					
SAMPLER(S)	**DATE TAKEN**	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Colby Paine/Ben Best	3/3/2022				

SAMPLE #	HOMOGENEOUS AREA	MATERIAL TYPE	LAB NUMBER	DATE ANALYZED	ANALYSTS INITIALS	ASBESTOS +	ASBESTOS N/D	ARCHIVE NUMBER	DATE ARCH	ARCHIVER INITIALS	SPECIAL INSTRUCTIONS
S-01	S	Foundation waterproofing	22-3082								
S-02			83								
T-01	T	Air cell pipe insulation	84								
T-02			85								
U-01	U	Hard elbow on air cell	86								
U-02			87								
V-01	V	hard elbow on foam insulation	88								
V-02			89								
W-01	W	Hardwood floor underlayment	90								
W-02			91								
X-01	X	Red firestop	92								
X-02			93								
Y-01	Y	Caulk (exterior of windows)	94								
Y-02			95								
Z-01	Z	Window glazing putty (exterior)	96								
Z-02			3097								

ALL SAMPLES WILL BE DISPOSED OF NINETY DAYS AFTER ANALYSIS UNLESS OTHERWISE REQUESTED

3-5 Day TAT
Positive Stop

This document was prepared pursuant to a specific agreement to address the unique requirements of an S&ME client

16 samples total

Analysis for Lead Concentration in Paint Chips

by Flame Atomic Absorption Spectroscopy
EPA SW-846 3050B/6010C/7000B

Customer: S&ME, Inc.
8646 West Market Street
Greensboro, NC 27409

Attn: Janet Phillips
Colby Paine

Project: UNC-CH - Bingham, Hall

Lab Order ID: 71986390
Analysis ID: 71986390_PBP
Date Received: 2/24/2022
Date Reported: 3/4/2022

Sample ID *Lab Sample ID*	Description *Lab Notes*	Mass *(g)*	Concentration *(ppm)*	Concentration *(% by weight)*
Pb-01 71986390PBP_1	Cream on metal radiator	0.0600	6000	**0.60%**
Pb-02 71986390PBP_2	Cream on metal window casing	0.0635	6600	**0.66%**

Xaviera Watkins (2)

Analyst

Laboratory Director

Scientific Analytical Institute
4604 Dundas Dr. Greensboro, NC 27407
Phone: 336.292.3888 Fax: 336.292.3313
www.sailab.com lab@sailab.com

Lab Use Only
Lab Order ID: 71986390
Client Code: _____

Contact Information

Company Name: S&ME - Greensboro	
Address:	
Contact: Janet Phillips (copy Colby Paine)	
Phone ☐:	
Fax ☐:	
Email ☐: jphillips@smeinc.com	
PO Number: Project No. 218984	
Project Name/Number: UNC-CH - Bingham Hall	

Billing/Invoice Information

Company:	
Address:	
	AP@smeinc.com
Contact:	
Phone ☐:	
Fax ☐:	
Email ☐:	

Lead Test Types

Paint Chips by Flame AA (PBP) ■	Soil by Flame AA (PBS) ☐	Other ☐
Wipe by Flame AA (PBW) ☐	Air by Flame AA (PBA) ☐	

Turn Around Times

3 Hours	☐	72 Hours	☐
6 Hours	☐	96 Hours	☐
12 Hours	☐	120 Hours	☒
24 Hours	☐	144+ Hours	☐
48 Hours	☐		

Sample ID #	Description/Location	Volume/Area	Comments
Pb-01	Cream on metal radiator		
Pb-02	Cream on metal window casing		

Accepted ☑
Rejected ☐

Total Number of Samples 2

Relinquished by	Date/Time	Received by	Date/Time
Colby Paine	2/24/22 1515	B Hulley	2/24 3:15 pm

Analysis for Lead Concentration in Paint Chips

by Flame Atomic Absorption Spectroscopy
EPA SW-846 3050B/6010C/7000B

Customer: S&ME, Inc.
8646 West Market Street
Greensboro, NC 27409

Attn: Janet Phillips
Colby Paine

Project: UNC-CH Bingham Hall

Lab Order ID: 71986992
Analysis ID: 71986992_PBP
Date Received: 3/4/2022
Date Reported: 3/9/2022

Sample ID *Lab Sample ID*	Description *Lab Notes*	Mass *(g)*	Concentration *(ppm)*	Concentration *(% by weight)*
PB-03 71986992PBP_1	Tan on exterior metal window frame	0.0725	130000	**13%**

Unless otherwise noted blank sample correction was not performed on analytical results. Scientific Analytical Institute participates in the AIHA ELPAT program. ELPAT Laboratory ID: 173190. This report relates only to the samples tested and may not be reproduced, except in full, without the written approval of SAI. Analytical uncertainty available upon request. The quality control samples run with the samples in this report have passed all EPA required specifications unless otherwise noted. RL: (Report Limit for an undiluted 50ml sample is 4µg Total Pb). Unless indicated, areas and volumes were provided by the customer.

Xaviera Watkins (1)

Analyst

Laboratory Director

Scientific Analytical Institute
4604 Dundas Dr. Greensboro, NC 27407
Phone: 336.292.3888 Fax: 336.292.3313
www.sailab.com lab@sailab.com

Lab Use Only
Lab Order ID: 71986992
Client Code: _____

Contact Information

Company Name:	SAME - Greensboro
Address:	
Contact:	Janet Phillips (copy Colby Paine)
Phone ☐:	
Fax ☐:	
Email ☐:	
PO Number:	Project No. 218984
Project Name/Number:	UNC-CH Bingham Hall

Billing/Invoice Information

Company:	
Address:	
Contact:	AP@SMEinc.com
Phone ☐:	
Fax ☐:	
Email ☐:	

Turn Around Times

3 Hours	☐	72 Hours	☐
6 Hours	☐	96 Hours	☐
12 Hours	☐	120 Hours	☒
24 Hours	☐	144+ Hours	☐
48 Hours	☐		

Lead Test Types

Paint Chips by Flame AA (PBP) ☒	Soil by Flame AA (PBS) ☐	Other ☐
Wipe by Flame AA (PBW) ☐	Air by Flame AA (PBA) ☐	

Sample ID #	Description/Location	Volume/Area	Comments
Pb-03	Tan on Exterior metal window frame		

Accepted ☑
Rejected ☐

Total Number of Samples 1

Relinquished by	Date/Time	Received by	Date/Time
Colby Paine	3/4/22		3/4 3:15pm

Limited Lead-based Paint Survey
The University of North Carolina at Chapel Hill, NC
Department of Environment, Health and Safety

Report Date: 01/23/07
Inspector: Kim Haley
XRF serial #: XL309-U863NR6995

Background

This limited lead-based paint survey was conducted in order to determine if the painted building components within Bingham Hall Room B-002 contain any concentrations of elemental lead. UNC-Chapel Hill personnel conducted the sampling using a Niton XL-309 X-ray Fluorescence (XRF) Analyzer.

The Occupational Safety and Health Administration's (OSHA) general industry (29 CFR 1910.1025) and construction standards (29 CFR 1926.62) for lead apply to all work where employees may be occupationally exposed to elemental metallic lead, inorganic lead compounds, and organic lead soaps (other organic lead compounds are not covered by this standard). **Any detectable levels of lead in materials are covered under these standards.**

The OSHA standards regulate occupational exposure by specifying acceptable airborne concentrations of lead (e.g. Action Level and Permissible Exposure Limit (PEL)). Employee exposure at or above these levels will require the employer to apply certain provisions of the standard (i.e. biological monitoring, employee training, and exposure control including respiratory protection).

Results

The highest elemental lead concentration results per the inspection request are as follows:

- Beige plaster wall: 0.21 mg/cm^2
- Beige brick wall: 0.38 mg/cm^2
- White plaster ceiling: 0.02 mg/cm^2

Air Monitoring

- During any construction work disturbing lead-containing materials, the employer/contractor is responsible for conducting employee airborne exposure monitoring for OSHA compliance and using appropriate exposure control measures as defined by the standard.
- **For construction work done by University employees, EHS will need to conduct employee airborne exposure monitoring during the following:**
  - **Removal of baseboard**
  - **Removal of loose wall paint**
- Employees are required to wear personal protective equipment such as coveralls, gloves and respirators until air monitoring results indicate the airborne concentration is acceptable.

Exposure Control Measures

- The prevention of dust generation can be achieved by the following:
  - Using power tools with local ventilation to capture dust at the source of generation.
  - Using wet methods during demolition to suppress dust generation.

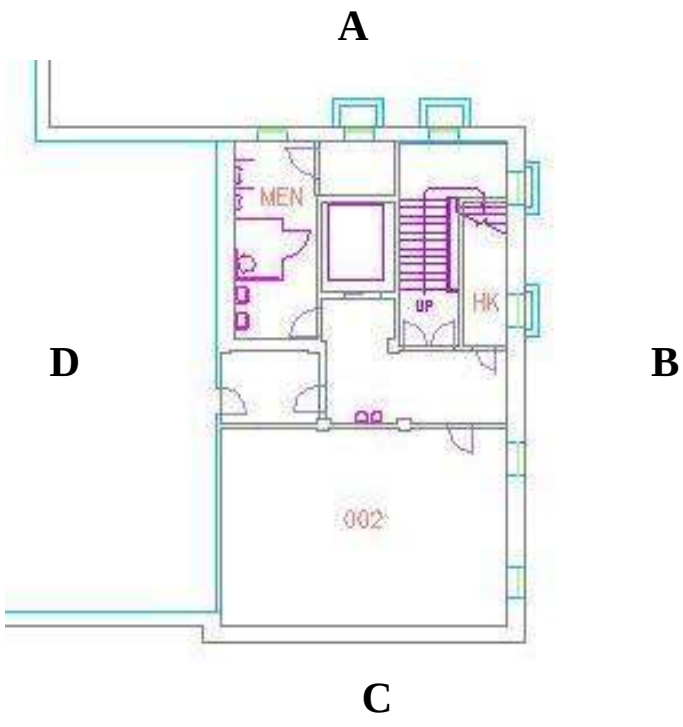
Hazardous Waste

- Prior to beginning work, where surveyed lead concentrations exceed 0.05 mg/cm^2, contact Mike Long (EHS-962-5723) to sample and test potential construction waste to determine if it should be categorized as hazardous waste. **Allow two weeks for testing results.**
- All paint chips created during paint removal needs to be collected, and stored in a locked container. These containers must be stored in a locked area and EHS must be called for a hazardous waste pickup (Mike Long 962-5723).

XRF Results

Serial #XL309-U863NR6995
Site: Bingham, Room B-002

No	Side	Room	Source	Sub	Cnd	Clr	Pb Content (mg/cm^2)
1		Shutter Cal 1					NA
2		Calibrate					1.02
3		Calibrate					1.02
4		Calibrate					1.03
5	B	B-002	Wall	Plaster	Intact	Beige	0.21
6	D	B-002	Wall	Brick	Intact	Beige	0.38
7		B-002	Ceiling	Plaster	Intact	White	0.02
8		Calibrate					1.01
9		Calibrate					1.00
10		Calibrate					0.98



UNC-CH DEPARTMENT OF ENVIRONMENT, HEALTH & SAFETY
Lead Based Paint Testing Data Sheet

Building: Bingham Hall
Room Equivalent: Room# 109
Inspector: NAGUI RIZKALLAH

Date: December 13, 2004
XRF: Niton XL-309, serial # 863

Sample ID#	Component	Substrate	Paint Color	Paint Condition	XRF (mg/cm^2)
04-xrf-530	Wall A	Plaster	Beige	Fair	0.07
04-xrf-531	Wall B	Plaster	Beige	Fair	0.10
04-xrf-532	Wall C	Plaster	Beige	Fair	0.07
04-xrf-533	Wall D	Plaster	Beige	Fair	0.08
04-xrf-534	Door casing	Metal	Beige	Poor	0.30
04-xrf-535	Window sill	Wood	Beige	Poor	0.35
04-xrf-536	Window sash	Metal	Beige	Poor	0.6
04-xrf-537	Window casing	Metal	Beige	Poor	0.43

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

March 11, 2022

Colby Paine
S&ME, Inc.
4646 West Market Street
Suite 105
Greensboro, NC 27409

RE: Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

Dear Colby Paine:

Enclosed are the analytical results for sample(s) received by the laboratory on March 07, 2022. The results relate only to the samples included in this report. Results reported herein conform to the applicable TNI/NELAC Standards and the laboratory's Quality Manual, where applicable, unless otherwise noted in the body of the report.

The test results provided in this final report were generated by each of the following laboratories within the Pace Network:

- Pace Analytical Services - Charlotte

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Angela M. Baioni

Angela Baioni
angela.baioni@pacelabs.com
(704)875-9092
Project Manager

Enclosures

cc: Janet Phillips, S&ME, Inc.

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

CERTIFICATIONS

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

Pace Analytical Services Charlotte

South Carolina Laboratory ID: 99006
9800 Kincey Ave. Ste 100, Huntersville, NC 28078
North Carolina Drinking Water Certification #: 37706
North Carolina Field Services Certification #: 5342
North Carolina Wastewater Certification #: 12
South Carolina Laboratory ID: 99006
South Carolina Certification #: 99006001
South Carolina Drinking Water Cert. #: 99006003
Florida/NELAP Certification #: E87627
Kentucky UST Certification #: 84
Louisiana DoH Drinking Water #: LA029
Virginia/VELAP Certification #: 460221

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

SAMPLE ANALYTE COUNT

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
92591765001	**PCB-01**	EPA 8082A	BAJ	8	PASI-C

PASI-C = Pace Analytical Services - Charlotte

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

ANALYTICAL RESULTS

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

Sample: PCB-01 **Lab ID: 92591765001** Collected: 03/03/22 08:00 Received: 03/07/22 13:45 Matrix: Solid

Results reported on a "wet-weight" basis

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8082 GCS PCB	Analytical Method: EPA 8082A Preparation Method: EPA 3546 Pace Analytical Services - Charlotte							
PCB-1016 (Aroclor 1016)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	12674-11-2	
PCB-1221 (Aroclor 1221)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	11104-28-2	
PCB-1232 (Aroclor 1232)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	11141-16-5	
PCB-1242 (Aroclor 1242)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	53469-21-9	
PCB-1248 (Aroclor 1248)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	12672-29-6	
PCB-1254 (Aroclor 1254)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	11097-69-1	
PCB-1260 (Aroclor 1260)	ND	mg/kg	0.50	1	03/10/22 11:25	03/10/22 13:05	11096-82-5	
Surrogates								
Decachlorobiphenyl (S)	47	%	10-160	1	03/10/22 11:25	03/10/22 13:05	2051-24-3	

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

QUALITY CONTROL DATA

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

QC Batch: 683776
QC Batch Method: EPA 3546
Analysis Method: EPA 8082A
Analysis Description: 8082 GCS PCB
Laboratory: Pace Analytical Services - Charlotte
Associated Lab Samples: 92591765001

METHOD BLANK: 3576152 Matrix: Solid
Associated Lab Samples: 92591765001

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
PCB-1016 (Aroclor 1016)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1221 (Aroclor 1221)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1232 (Aroclor 1232)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1242 (Aroclor 1242)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1248 (Aroclor 1248)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1254 (Aroclor 1254)	mg/kg	ND	0.033	03/10/22 13:47	
PCB-1260 (Aroclor 1260)	mg/kg	ND	0.033	03/10/22 13:47	
Decachlorobiphenyl (S)	%	92	10-160	03/10/22 13:47	

LABORATORY CONTROL SAMPLE: 3576153

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
PCB-1016 (Aroclor 1016)	mg/kg	0.17	0.15	89	54-130	
PCB-1260 (Aroclor 1260)	mg/kg	0.17	0.14	87	47-139	
Decachlorobiphenyl (S)	%			94	10-160	

MATRIX SPIKE SAMPLE: 3576154

Parameter	Units	92591529001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
PCB-1016 (Aroclor 1016)	mg/kg	ND	0.6	0.56	96	17-131	
PCB-1260 (Aroclor 1260)	mg/kg	ND	0.6	0.26	44	10-142	
Decachlorobiphenyl (S)	%				53	10-160	

SAMPLE DUPLICATE: 3576155

Parameter	Units	92591893001 Result	Dup Result	RPD	Qualifiers
PCB-1016 (Aroclor 1016)	mg/kg	ND	ND		
PCB-1221 (Aroclor 1221)	mg/kg	ND	ND		
PCB-1232 (Aroclor 1232)	mg/kg	ND	ND		
PCB-1242 (Aroclor 1242)	mg/kg	ND	ND		
PCB-1248 (Aroclor 1248)	mg/kg	ND	ND		
PCB-1254 (Aroclor 1254)	mg/kg	ND	ND		
PCB-1260 (Aroclor 1260)	mg/kg	ND	ND		
Decachlorobiphenyl (S)	%	71	75		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

REPORT OF LABORATORY ANALYSIS

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

QUALIFIERS

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit - The lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

Acid preservation may not be appropriate for 2 Chloroethylvinyl ether.

A separate vial preserved to a pH of 4-5 is recommended in SW846 Chapter 4 for the analysis of Acrolein and Acrylonitrile by EPA Method 8260.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Reported results are not rounded until the final step prior to reporting. Therefore, calculated parameters that are typically reported as "Total" may vary slightly from the sum of the reported component parameters.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

Pace Analytical Services, LLC
9800 Kincey Ave. Suite 100
Huntersville, NC 28078
(704)875-9092

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: UNC CH -Bingham Hall
Pace Project No.: 92591765

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
92591765001	**PCB-01**	EPA 3546	683776	EPA 8082A	683909

WO# : 92591765

92591765

CHAIN-OF-CUSTODY Analytical Request Document

Pace Analytical

Submitting a sample via this chain of custody constitutes acknowledgment and acceptance of the Pace Terms and Conditions found at: https://info.pacelabs.com/hubfs/pas-standard-terms.pdf

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevant fields

LAI ... Number or ... NLY

Company: S&ME, Inc.	Billing Information: AP@smeinc.com
Address: 8646 West Market Street, Suite 105 Greensboro, NC 27409	
Report To: Janet Phillips (jphillips@smeinc.com)	Email To:
Copy To: Colby Paine (cpaine@smeinc.com)	Site Collection Info/Address:
Customer Project Name/Number: UNC CH - Bingham Hall; Project No. 218984	State: / County/City: Time Zone Collected: [ ]PT [ ]MT [ ]CT [ ]ET

Phone: Email:	Site/Facility ID #:	Compliance Monitoring? [ ] Yes [ ] No
Collected By (print): Colby Paine/Ben Best	Purchase Order # : Quote #:	DW PWS ID #: DW Location Code:
Collected By (signature): Colby Paine	Turnaround Date Required: 3/11/22	Immediately Packed on Ice: [ ] Yes [ ] No
Sample Disposal: [ ] Dispose as appropriate [ ] Return [ ] Archive: ____ [ ] Hold: ____	Rush: (Expedite Charges Apply) [ ] Same Day [ ] Next Day [ ] 2 Day [ ] 3 Day [ ] 4 Day [ ] 5 Day	Field Filtered (if applicable): [ ] Yes [ ] No Analysis: ____

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start) Date	Collected (or Composite Start) Time	Composite End Date	Composite End Time	Res Cl	# of Ctns	Container Type: Plastic (P) or Glass (G)	PCBs by 8082
PCB-01	SL	G	3/3/2022	800				1	G	x

Container Preservative Type **: U

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) hydrochloric acid, (4) sodium hydroxide, (5) zinc acetate, (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, (9) hexane, (A) ascorbic acid, (B) ammonium sulfate, (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other ____

Lab Project Manager:

Analyses

Lab Profile/Line: 15281-1

Lab Sample Receipt Checklist:

Custody Seals Present/Intact	Y (N) NA
Custody Signatures Present	(Y) N NA
Collector Signature Present	(Y) N NA
Bottles Intact	(Y) N NA
Correct Bottles	(Y) N NA
Sufficient Volume	Y (N) NA
Samples Received on Ice	(Y) N NA
VOA - Headspace Acceptable	Y N (NA)
USDA Regulated Soils	Y (N) NA
Samples in Holding Time	(Y) N NA
Residual Chlorine Present	Y (N) NA
Cl Strips: ____	
Sample pH Acceptable	Y N (NA)
pH Strips: ____	
Sulfide Present	Y N (NA)
Lead Acetate Strips: ____	

LAB USE ONLY:
Lab Sample # / Comments:

92591765
001

Customer Remarks / Special Conditions / Possible Hazards:

Type of Ice Used: (Wet) Blue Dry None

Packing Material Used: None

Radchem sample(s) screened (<500 cpm): Y N (NA)

SHORT HOLDS PRESENT (<72 hours): Y (N) N/A

Lab Tracking #:

Samples received via: FEDEX UPS (Client) Courier Pace Courier

LAB Sample Temperature Info:
Temp Blank Received: Y (N) NA
Therm ID#: IR Gun 2
Cooler 1 Temp Upon Receipt: 1 oC
Cooler 1 Therm Corr. Factor: 0 oC
Cooler 1 Corrected Temp: 1 oC
Comments:

Relinquished by/Company: (Signature) Colby Paine	Date/Time: 3/3/22	Received by/Company: (Signature)	Date/Time: 3/7/22 1345
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:
Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:

MTJL LAB USE ONLY
Table #:
Acctnum:
Template:
Prelogin:
PM:
PB:

Trip Blank Received: Y (N) NA
HCL MeOH TSP Other

Non Conformance(s): YES / NO

Page: 1 of: 1

Pace Analytical™	Document Name: Bottle Identification Form (BIF)	Document Issued: November 15, 2021 Page 1 of 1
	Document No.: F-CAR-CS-043-Rev.01	Issuing Authority: Pace Carolinas Quality Office

*Check mark top half of box if pH and/or dechlorination is verified and within the acceptance range for preservation samples.

Exceptions: VOA, Coliform, TOC, Oil and Grease, DRO/8015 (water) DOC, LLHg

**Bottom half of box is to list number of bottles

Project # **WO# : 92591765**

PM: AMB **Due Date: 03/14/22**

CLIENT: 92-S&ME Gbor

Matrix	Item#	BP4U-125 mL Plastic Unpreserved (N/A) (Cl-)	BP3U-250 mL Plastic Unpreserved (N/A)	BP2U-500 mL Plastic Unpreserved (N/A)	BP1U-1 liter Plastic Unpreserved (N/A)	BP4S-125 mL Plastic H2SO4 (pH < 2) (Cl-)	BP3N-250 mL plastic HNO3 (pH < 2)	BP4Z-125 mL Plastic ZN Acetate & NaOH (>9)	BP4B-125 mL Plastic NaOH (pH > 12) (Cl-)	WGFU-Wide-mouthed Glass jar Unpreserved	AG1U-1 liter Amber Unpreserved (N/A) (Cl-)	AG1H-1 liter Amber HCl (pH < 2)	AG3U-250 mL Amber Unpreserved (N/A) (Cl-)	AG1S-1 liter Amber H2SO4 (pH < 2)	AG3S-250 mL Amber H2SO4 (pH < 2)	AG3A(DG3A)-250 mL Amber NH4Cl (N/A)(Cl-)	DG9H-40 mL VOA HCl (N/A)	VG9T-40 mL VOA Na2S2O3 (N/A)	VG9U-40 mL VOA Unpreserved (N/A)	DG9P-40 mL VOA H3PO4 (N/A)	VOAK (3 vials per kit)-5035 kit (N/A)	V/GK (3 vials per kit)-VPH/Gas kit (N/A)	SP5T-125 mL Sterile Plastic (N/A – lab)	SP2T-250 mL Sterile Plastic (N/A – lab)	AG3U*	BP3A-250 mL Plastic (NH2)2SO4 (9.3-9.7)	AG0U-100 mL Amber Unpreserved vials (N/A)	VSGU-20 mL Scintillation vials (N/A)	DG9U-40 mL Amber Unpreserved vials (N/A)
	1																													
	2																													
	3																													
	4																													
	5																													
	6																													
	7																													
	8																													
	9																													
	10																													
	11																													
	12																													

pH Adjustment Log for Preserved Samples

Sample ID	Type of Preservative	pH upon receipt	Date preservation adjusted	Time preservation adjusted	Amount of Preservative added	Lot #

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e. Out of hold, incorrect preservative, out of temp, incorrect containers.

* Small amount of sample submitted. Approx 3-5g. total. SBC 3/7/22

SECTION 00 30 00 - INFORMATION AVAILABLE TO BIDDERS

EXISTING REPORTS AND SURVEYS

1.01 HAZARDOUS MATERIALS ASSESSMENT

A. A copy of the hazardous materials report is bound into the project manual immediately following this document.

END OF SECTION

F O R M O F P R O P O S A L

Bingham Hall Comprehensive Renovation
University of North Carolina at Chapel Hill
SCO-ID # 21-23548-02A

Contract: Single Prime General Contract
Bidder: _____
Date: _____

The undersigned, as bidder, hereby declares that the only person or persons interested in this proposal as principal or principals is or are named herein and that no other person than herein mentioned has any interest in this proposal or in the contract to be entered into; that this proposal is made without connection with any other person, company or parties making a bid or proposal; and that it is in all respects fair and in good faith without collusion or fraud. The bidder further declares that he has examined the site of the work and the contract documents relative thereto, and has read all special provisions furnished prior to the opening of bids; that he has satisfied himself relative to the work to be performed. The bidder further declares that he and his subcontractors have fully complied with NCGS 64, Article 2 in regards to E-Verification as required by Section 2.(c) of Session Law 2013-418, codified as N.C. Gen. Stat. § 143-129(j).

.

The Bidder proposes and agrees if this proposal is accepted to contract with the State of North Carolina through the University of North Carolina at Chapel Hill in the form of contract specified below, to furnish all necessary materials, equipment, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction of Bingham Hall Comprehensive Renovation in full in complete accordance with the plans, specifications and contract documents, to the full and entire satisfaction of the State of North Carolina, and the University of North Carolina at Chapel Hill with a definite understanding that no money will be allowed for extra work except as set forth in the General Conditions and the contract documents, for the sum of:

SINGLE PRIME CONTRACT:

Base Bid:

_____ Dollars($) _____

General Subcontractor:

_____ Lic _____

Plumbing Subcontractor:

_____ Lic _____

Mechanical Subcontractor:

_____ Lic _____

Electrical Subcontractor:

_____ Lic _____

GS143-128(d) requires all single prime bidders to identify their subcontractors for the above subdivisions of work. A contractor whose bid is accepted shall not substitute any person as subcontractor in the place of the subcontractor listed in the original bid, except (i) if the listed subcontractor's bid is later determined by the contractor to be non-responsible or non-responsive or the listed subcontractor refuses to enter into a contract for the complete performance of the bid work, or (ii) with the approval of the awarding authority for good cause shown by the contractor.

ALTERNATES:

Should any of the alternates as described in the contract documents be accepted, the amount written below shall be the amount to be "added to" the base bid.

Alternate No. A1: Aluminum Replacement Windows
(Add) _____ Dollars($) _____

Alternate No. A2: Elevator Cab Interior Finishes
(Add) _____ Dollars($) _____

Alternate No. A3: Stair Landings Floor Finish
(Add) Dollars($)_____

Alternate No. A4: Low-e Coating on New Storm Windows
(Add) Dollars($)_____

Alternate No. C1: Storm Drainage Improvements along West Side of Building
(Add) Dollars($)_____

Alternate No. PB-1: Owner Preferred Hydronic System Water Treatment
(Add) Dollars($)_____

Alternate No. PB-2: Owner Preferred Variable Frequency Drive (VFD) Cables
(Add) Dollars($)_____

Alternate No. PB-3: Owner Preferred Butterfly Valves
(Add) Dollars($)_____

Alternate No. PB-4: Owner Preferred Balancing Valves
(Add) Dollars($)_____

Alternate No. PB-5: Owner Preferred Pressure Reducing Valves
(Add) Dollars($)_____

Alternate No. PB-6: Owner Preferred Mechanical Access Doors
(Add) Dollars($)_____

Alternate No. PB-7: Owner Preferred Drinking Fountains
(Add) Dollars($)_____

Alternate No. PB-8: Owner Preferred Door Hardware
(Add) Dollars($)_____

Alternate No. PB-9: Owner Preferred Tile Carpet
(Add) Dollars($)_____

UNIT PRICES

Unit prices quoted and accepted shall apply throughout the life of the contract, except as otherwise specifically noted. Unit prices shall be applied, as appropriate, to compute the total value of changes in the base bid quantity of the work all in accordance with the contract documents.

No. A1: Repointing of Brick Masonry (*SF*) Unit Price ($)_____

No. A2: New Slate Roof Shingles (*SF*) Unit Price ($)_____

No. C1: Rock Excavation and Disposal Offsite (*CY*) Unit Price ($)_____

No. C2: Unsuitable Soils Excavation and Disposal Offsite (*CY*) Unit Price ($)_____

No. C3: Replacement of Removed Rock or Unsuitable Soils with Aggregate Base Course In-Place (*CY*)
Unit Price ($)_____

No. C4: Replacement of Removed Rock or Unsuitable Soils with No. 57 Washed Stone In-Place (*CY*)
Unit Price ($)_____

No. C5: Replacement of Removed Rock or Unsuitable Soils with Excavatable Flowable Fill In-Place (*CY*)
Unit Price ($)_____

No. S1: Infill of Openings in Existing Floors, size between 6”-9” (*Each*) Unit Price ($)_____

No. S2: Infill of Openings in Existing Floors, size between 9”-32” (*Each*) Unit Price ($)_____

The bidder further proposes and agrees hereby to commence work under this contract on a date to be specified in a written order of the designer and shall fully complete all work thereunder within the time specified in the Supplementary General Conditions Article 23. Applicable liquidated damages amount is also stated in the Supplementary General Conditions Article 23.

MINORITY BUSINESS PARTICIPATION REQUIREMENTS

Provide with the bid - Under GS 143-128.2(c) the undersigned bidder shall identify **on its bid** (Identification of Minority Business Participation Form) the minority businesses that it will use on the project with the total dollar value of the bids that will be performed by the minority businesses. **Also** list the good faith efforts (Affidavit **A**) made to solicit minority participation in the bid effort.

After the bid opening - The Owner will consider all bids and alternates and determine the lowest responsible, responsive bidder. Upon notification of being the apparent low bidder, the bidder shall then file within 72 hours of the notification of being the apparent lowest bidder, one of the following:

An Affidavit (**B**) identifying intent to perform contract with own workforce. All evidentiary documents to prove good faith efforts from Affidavit **A** must also be provided;

*** OR ***

An Affidavit (**C**) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the 10% goal established. This affidavit shall give rise to the presumption that the bidder has made the required good faith effort and Affidavit **D** is not necessary;

*** OR ***

If less than the 10% goal, Affidavit (**D**) of its good faith effort to meet the goal shall be provided. The document must include evidence of all good faith efforts that were implemented, including any advertisements, solicitations and other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract.

Note: Bidders must always submit **with their bid** the Identification of Minority Business Participation Form listing all MB contractors, vendors and suppliers that will be used. If there is no MB participation, then enter none or zero on the form. Affidavit A also must be submitted with the bid. Failure to file a required affidavit or documentation with the bid or after being notified apparent low bidder is grounds for rejection of the bid.

Proposal Signature Page

The undersigned further agrees that in the case of failure on his part to execute the said contract and the bonds within ten (10) consecutive calendar days after being given written notice of the award of contract, the certified check, cash or bid bond accompanying this bid shall be paid into the funds of the owner's account set aside for the project, as liquidated damages for such failure; otherwise the certified check, cash or bid bond accompanying this proposal shall be returned to the undersigned.

Respectfully submitted this day of _____

_____
(Name of firm or corporation making bid)

WITNESS:

_____
(Proprietorship or Partnership)

By:_____
Signature

Name: _____
Print or type

Title_____
(Owner/Partner/Pres./V.Pres)

Address_____

_____

ATTEST:

By:_____

Title:_____
(Corp. Sec. or Asst. Sec. only)

License No._____

Federal I.D. No. _____

Email Address: _____

(CORPORATE SEAL)

Addendum received and used in computing bid:

Addendum No. 1 ____

Confirm in the space provided below that this bid includes the open protocol lighting control system, devices and interfaces as specified in division 26; specifically as noted in section 26 09 43.19 Addressable Luminaire Lighting Controls and on the Lighting Control Detail Sheets.
Confirmed _____

FORM OF BID BOND

KNOW ALL MEN BY THESE PRESENTS THAT _____ _____ as principal, and _____, as surety, who is duly licensed to act as surety in North Carolina, are held and firmly bound unto the State of North Carolina* through _____ as obligee, in the penal sum of _____ DOLLARS, lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

Signed, sealed and dated this ____ day of _____ 20__

WHEREAS, the said principal is herewith submitting proposal for and the principal desires to file this bid bond in lieu of making the cash deposit as required by G.S. 143-129.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION is such, that if the principal shall be awarded the contract for which the bid is submitted and shall execute the contract and give bond for the faithful performance thereof within ten days after the award of same to the principal, then this obligation shall be null and void; but if the principal fails to so execute such contract and give performance bond as required by G.S. 143-129, the surety shall, upon demand, forthwith pay to the obligee the amount set forth in the first paragraph hereof. Provided further, that the bid may be withdrawn as provided by G.S. 143-129.1

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

_____(SEAL)

Identification of HUB Certified/ Minority Business Participation

I,_____,
(Name of Bidder)

do hereby certify that on this project, we will use the following HUB Certified/ minority business as construction subcontractors, vendors, suppliers or providers of professional services.

Firm Name, Address and Phone #	Work Type	*Minority Category	**HUB Certified (Y/N)

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

The total value of minority business contracting will be ($)_____.

State of North Carolina AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of_____

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive. (1 NC Administrative Code 30 I.0101)

- ❑ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ❑ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ❑ **3 – (15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ❑ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ❑ **5 – (10 pts)** Attended prebid meetings scheduled by the public owner.
- ❑ **6 – (20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ❑ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ❑ **8 – (25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ❑ **9 – (20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ❑ **10 - (20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date:_____ Name of Authorized Officer:_____

Signature:_____

Title:_____

SEAL

State of_____, County of_____

Subscribed and sworn to before me this _____ day of _____ 20____

Notary Public_____

My commission expires_____

State of North Carolina --AFFIDAVIT B-- Intent to Perform Contract with Own Workforce.

County of _____

Affidavit of _____
(Name of Bidder)

I hereby certify that it is our intent to perform 100% of the work required for the _____

_____ contract.
(Name of Project)

In making this certification, the Bidder states that the Bidder does not customarily subcontract elements of this type project, and normally performs and has the capability to perform and will perform all elements of the work on this project with his/her own current work forces; and

The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement. The Bidder agrees to make a Good Faith Effort to utilize minority suppliers where possible.

The undersigned hereby certifies that he or she has read this certification and is authorized to bind the Bidder to the commitments herein contained.

Date: _____ Name of Authorized Officer: _____

Signature: _____

Title: _____

SEAL

State of _____, County of _____

Subscribed and sworn to before me this _____ day of _____ 20___

Notary Public _____

My commission expires _____

Do not submit with bid Do not submit with bid Do not submit with bid Do not submit with bid

State of North Carolina - AFFIDAVIT C - Portion of the Work to be Performed by HUB Certified/Minority Businesses

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the portion of the work to be executed by HUB certified/minority businesses as defined in GS143-128.2(g) and 128.4(a),(b),(e) is equal to or greater than 10% of the bidders total contract price, then the bidder must complete this affidavit.
This affidavit shall be provided by the apparent lowest responsible, responsive bidder within **72 hours** after notification of being low bidder.

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

_____
(Project Name)

Project ID#_____ Amount of Bid $_____

I will expend a minimum of _____% of the total dollar amount of the contract with minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. Attach additional sheets if required

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date:_____ Name of Authorized Officer:_____

SEAL

Signature:_____

Title:_____

State of _____, County of _____
Subscribed and sworn to before me this _____ day of _____ 20____
Notary Public_____
My commission expires_____

State of North Carolina AFFIDAVIT D – Good Faith Efforts

County of _____

(Note this form is to be submitted only by the apparent lowest responsible, responsive bidder.)

If the goal of 10% participation by HUB Certified/ minority business **is not** achieved, the Bidder shall provide the following documentation to the Owner of his good faith efforts:

Affidavit of _____ I do hereby certify that on the
(Name of Bidder)

_____
(Project Name)

Project ID#_____ Amount of Bid $_____

I will expend a minimum of _____% of the total dollar amount of the contract with HUB certified/ minority business enterprises. Minority businesses will be employed as construction subcontractors, vendors, suppliers or providers of professional services. Such work will be subcontracted to the following firms listed below. (Attach additional sheets if required)

Name and Phone Number	*Minority Category	**HUB Certified Y/N	Work Description	Dollar Value

***Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

Examples of documentation that may be required to demonstrate the Bidder's good faith efforts to meet the goals set forth in these provisions include, but are not necessarily limited to, the following:

A. Copies of solicitations for quotes to at least three (3) minority business firms from the source list provided by the State for each subcontract to be let under this contract (if 3 or more firms are shown on the source list). Each solicitation shall contain a specific description of the work to be subcontracted, location where bid documents can be reviewed, representative of the Prime Bidder to contact, and location, date and time when quotes must be received.

B. Copies of quotes or responses received from each firm responding to the solicitation.

C. A telephone log of follow-up calls to each firm sent a solicitation.

D. For subcontracts where a minority business firm is not considered the lowest responsible sub-bidder, copies of quotes received from all firms submitting quotes for that particular subcontract.

E. Documentation of any contacts or correspondence to minority business, community, or contractor organizations in an attempt to meet the goal.

F. Copy of pre-bid roster

G. Letter documenting efforts to provide assistance in obtaining required bonding or insurance for minority business.

H. Letter detailing reasons for rejection of minority business due to lack of qualification.

I. Letter documenting proposed assistance offered to minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letter of credit, including waiving credit that is ordinarily required.

Failure to provide the documentation as listed in these provisions may result in rejection of the bid and award to the next lowest responsible and responsive bidder.

Pursuant to GS143-128.2(d), the undersigned will enter into a formal agreement with Minority Firms for work listed in this schedule conditional upon execution of a contract with the Owner. Failure to fulfill this commitment may constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of this commitment and is authorized to bind the bidder to the commitment herein set forth.

Date:_____ Name of Authorized Officer:_____

Signature:_____

Title:_____

SEAL

State of_____, County of _____

Subscribed and sworn to before me this _____day of _____20____

Notary Public_____

My commission expires_____

FORM OF CONSTRUCTION CONTRACT

(ALL PRIME CONTRACTS)

THIS AGREEMENT, made the _____ day of _____ in the year of 20__ by and between _____ _____ hereinafter called the Party of the First Part and the State of North Carolina, through the_____ _____ hereinafter called the Party of the Second Part.

WITNESSETH:

That the Party of the First Part and the Party of the Second Part for the consideration herein named agree as follows:

1. Scope of Work: The Party of the First Part shall furnish and deliver all of the materials, and perform all of the work in the manner and form as provided by the following enumerated plans, specifications and documents, which are attached hereto and made a part thereof as if fully contained herein: advertisement; Instructions to Bidders; General Conditions; Supplementary General Conditions; specifications; accepted proposal; contract; performance bond; payment bond; power of attorney; workmen's compensation; public liability; property damage and builder's risk insurance certificates; approval of attorney general; certificate by the Office of State Budget and Management, and drawings, titled:

_____

_____

_____

Consisting of the following sheets:

_____

_____

_____

_____

Dated: _____ and the following addenda:

Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____

Addendum No _____ Dated: _____ Addendum No. _____ Dated: _____

2. That the Party of the First Part shall commence work to be performed under this agreement on a date to be specified in a written order of the Party of the Second Part and shall fully complete all work hereunder within _____ consecutive calendar days

from said date. For each day in excess thereof, liquidated damages shall be as stated in Supplementary General Conditions. The Party of the First Part, as one of the considerations for the awarding of this contract, shall furnish to the Party of the Second Part a construction schedule setting forth planned progress of the project broken down by the various divisions or part of the work and by calendar days as outlined in Article 14 of the General Conditions of the Contract.

3. The Party of the Second Part hereby agrees to pay to the Party of the First Part for the faithful performance of this agreement, subject to additions and deductions as provided in the specifications or proposal, in lawful money of the United States as follows:

_____

_____($_____).

Summary of Contract Award:

4. In accordance with Article 31 and Article 32 of the General Conditions of the Contract, the Party of the Second Part shall review, and if approved, process the Party of the First Party's pay request within 30 days upon receipt from the Designer. The Party of the Second Part, after reviewing and approving said pay request, shall make payments to the Party of the First Part on the basis of a duly certified and approved estimate of work performed during the preceding calendar month by the First Party, less five percent (5%) of the amount of such estimate which is to be retained by the Second Party until all work has been performed strictly in accordance with this agreement and until such work has been accepted by the Second Party. The Second Party may elect to waive retainage requirements after 50 percent of the work has been satisfactorily completed on schedule as referred to in Article 31 of the General Conditions.

5. Upon submission by the First Party of evidence satisfactory to the Second Party that all payrolls, material bills and other costs incurred by the First Party in connection with the construction of the work have been paid in full, final payment on account of this agreement shall be made within thirty (30) days after the completion by the First Party of all work covered by this agreement and the acceptance of such work by the Second Party.

6. It is further mutually agreed between the parties hereto that if at any time after the execution of this agreement and the surety bonds hereto attached for its faithful performance, the Second Party shall deem the surety or sureties upon such bonds to be unsatisfactory, or if, for any reason, such bonds cease to be adequate to cover the performance of the work, the First Party shall, at its expense, within five (5) days after the receipt of notice from the Second Party so to do, furnish an additional bond or bonds in such form and amount, and with such surety or sureties as shall be satisfactory to the Second Party. In such event no further payment to the First Party shall be deemed to be due under this agreement until such new or additional security for the faithful performance of the work shall be furnished in manner and form satisfactory to the Second Party.

7. The Party of the First Part attest that it and all of its subcontractors have fully complied with all requirements of NCGS 64 Article 2 in regards to E-Verification as required by Section 2.(c) of Session Law 2013-418, codified as N.C. Gen. Stat. § 143-129(j).

IN WITNESS WHEREOF, the Parties hereto have executed this agreement on the day and date first above written in _____ counterparts, each of which shall without proof or accounting for other counterparts, be deemed an original contract.

Witness:

_____
Contractor: (Trade or Corporate Name)

_____
(Proprietorship or Partnership)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

The State of North Carolina through*

(CORPORATE SEAL)

_____
(Agency, Department or Institution)

Witness:

_____

By:_____

Title: _____

FORM OF PERFORMANCE BOND

Date of Contract: _____

Date of Execution: _____

Name of Principal (Contractor) _____

Name of Surety: _____

Name of Contracting Body: _____

Amount of Bond: _____

Project

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind, ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body, identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the contracting body, with or without notice to the surety, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness:

_____
(Proprietorship or Partnership)

Attest: (Corporation)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec. only)

(Corporate Seal)

_____
Contractor: (Trade or Corporate Name)

By: _____

Title: _____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

_____
(Surety Company)

Witness:

_____

By: _____

Title: _____
(Attorney in Fact)

Countersigned:

_____

_____
(N.C. Licensed Resident Agent)

_____

_____
Name and Address-Surety Agency

_____

_____
Surety Company Name and N.C. Regional or Branch Office Address

(Surety Corporate Seal)

FORM OF PAYMENT BOND

Date of Contract: _____

Date of Execution: _____

Name of Principal (Contractor) _____

Name of Surety: _____

Name of Contracting Body: _____

Amount of Bond: _____

Project _____

KNOW ALL MEN BY THESE PRESENTS, that we, the principal and surety above named, are held and firmly bound unto the above named contracting body, hereinafter called the contracting body, in the penal sum of the amount stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract with the contracting body identified as shown above and hereto attached:

NOW, THEREFORE, if the principal shall promptly make payment to all persons supplying labor/material in the prosecution of the work provided for in said contract, and any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, then this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Executed in _____ counterparts.

Witness:

_____
Contractor: (Trade or Corporate Name)

_____
(Proprietorship or Partnership)

By: _____

Attest: (Corporation)

Title_____
(Owner, Partner, or Corp. Pres. or Vice Pres. only)

By: _____

Title: _____
(Corp. Sec. or Asst. Sec.. only)

(Corporate Seal)

_____
(Surety Company)

Witness:

By: _____

_____

Title: _____
(Attorney in Fact)

Countersigned:

_____

(Surety Corporate Seal)

_____
(N.C. Licensed Resident Agent)

_____

_____
Name and Address-Surety Agency

_____

_____
Surety Company Name and N.C.
Regional or Branch Office Address

Sheet for Attaching Power of Attorney

Sheet for Attaching Insurance Certificates

APPROVAL OF CAMPUS LEGAL COUNSEL

Insurance Certificate – Cancellation Notification Provisions

Many insurance certificates have cancellation notification provisions that conflict with our requirements in the contract General Conditions Article 34. To resolve this conflict in a way acceptable to DOI and SCO, the following wording should be added on the certificate in the block labeled "Description of operations, Vehicles, Exclusions added by endorsements/Special Provisions:"

"Not withstanding the preprinted cancellation provisions on this form, coverages afforded under the policies will not be cancelled, reduced in amount nor will any coverages be eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the owner, of such alteration or cancellation."

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GUIDELINES FOR RECRUITMENT AND SELECTION OF MINORITY BUSINESSES FOR PARTICIPATION IN STATE CONSTRUCTION CONTRACTS

In accordance with G.S. 143-128.2 (effective January 1, 2002) these guidelines establish goals for minority participation in single-prime bidding, separate-prime bidding, construction manager at risk, and alternative contracting methods, on State construction projects in the amount of $300,000 or more. The legislation provides that the State shall have a verifiable ten percent (10%) goal for participation by minority businesses in the total value of work for each project for which a contract or contracts are awarded. These requirements are published to accomplish that end.

SECTION A: INTENT

It is the intent of these guidelines that the State of North Carolina, as awarding authority for construction projects, and the contractors and subcontractors performing the construction contracts awarded shall cooperate and in good faith do all things legal, proper and reasonable to achieve the statutory goal of ten percent (10%) for participation by minority businesses in each construction project as mandated by GS 143-128.2. Nothing in these guidelines shall be construed to require contractors or awarding authorities to award contracts or subcontracts to or to make purchases of materials or equipment from minority-business contractors or minority-business subcontractors who do not submit the lowest responsible, responsive bid or bids.

SECTION B: DEFINITIONS

1. Minority - a person who is a citizen or lawful permanent resident of the United States and who is:
   a. Black, that is, a person having origins in any of the black racial groups in Africa;
   b. Hispanic, that is, a person of Spanish or Portuguese culture with origins in Mexico, South or Central America, or the Caribbean Islands, regardless of race;
   c. Asian American, that is, a person having origins in any of the original peoples of the Far East, Southeast Asia and Asia, the Indian subcontinent, the Pacific Islands;
   d. American Indian, that is, a person having origins in any of the original peoples of North America; or
   e. Female

2. Minority Business - means a business:
   a. In which at least fifty-one percent (51%) is owned by one or more minority persons, or in the case of a corporation, in which at least fifty-one percent (51%) of the stock is owned by one or more minority persons or socially and economically disadvantaged individuals; and
   b. Of which the management and daily business operations are controlled by one or more of the minority persons or socially and economically disadvantaged individuals who own it.

3. Socially and economically disadvantaged individual - means the same as defined in 15 U.S.C. 637. "Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities". "Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged".

4. Public Entity - means State and all public subdivisions and local governmental units.

5. Owner - The State of North Carolina, through the Agency/Institution named in the contract.

6. Designer – Any person, firm, partnership, or corporation, which has contracted with the State of North Carolina to perform architectural or engineering, work.

7. Bidder - Any person, firm, partnership, corporation, association, or joint venture seeking to be awarded a public contract or subcontract.

8. Contract - A mutually binding legal relationship or any modification thereof obligating the seller to furnish equipment, materials or services, including construction, and obligating the buyer to pay for them.

9. Contractor - Any person, firm, partnership, corporation, association, or joint venture which has contracted with the State of North Carolina to perform construction work or repair.

10. Subcontractor - A firm under contract with the prime contractor or construction manager at risk for supplying materials or labor and materials and/or installation. The subcontractor may or may not provide materials in his subcontract.

SECTION C: RESPONSIBILITIES

1. Office for Historically Underutilized Businesses, Department of Administration (hereinafter referred to as HUB Office).

   The HUB Office has established a program, which allows interested persons or businesses qualifying as a minority business under G.S. 143-128.2, to obtain certification in the State of North Carolina procurement system. The information provided by the minority businesses will be used by the HUB Office to:
   a. Identify those areas of work for which there are minority businesses, as requested.
   b. Make available to interested parties a list of prospective minority business contractors and subcontractors.
   c. Assist in the determination of technical assistance needed by minority business contractors.

   In addition to being responsible for the certification/verification of minority businesses that want to participate in the State construction program, the HUB Office will:
   (1) Maintain a current list of minority businesses. The list shall include the areas of work in which each minority business is interested.
   (2) Inform minority businesses on how to identify and obtain contracting and subcontracting opportunities through the State Construction Office and other public entities.
   (3) Inform minority businesses of the contracting and subcontracting process for public construction building projects.
   (4) Work with the North Carolina trade and professional organizations to improve the ability of minority businesses to compete in the State construction projects.
   (5) The HUB Office also oversees the minority business program by:
      a. Monitoring compliance with the program requirements.
      b. Assisting in the implementation of training and technical assistance programs.
      c. Identifying and implementing outreach efforts to increase the utilization of minority businesses.
      d. Reporting the results of minority business utilization to the Secretary of the Department of Administration, the Governor, and the General Assembly.

2. State Construction Office
   The State Construction Office will be responsible for the following:

   a. Furnish to the HUB Office a minimum of twenty-one days prior to the bid opening the following:
      (1) Project description and location;
      (2) Locations where bidding documents may be reviewed;
      (3) Name of a representative of the owner who can be contacted during the advertising period to advise who the prospective bidders are;
      (4) Date, time and location of the bid opening.
      (5) Date, time and location of prebid conference, if scheduled.

   b. Attending scheduled prebid conference, if necessary, to clarify requirements of the general statutes regarding minority-business participation, including the bidders' responsibilities.

c. Reviewing the apparent low bidders' statutory compliance with the requirements listed in the proposal, that must be complied with, if the bid is to be considered as responsive, prior to award of contracts. The State reserves the right to reject any or all bids and to waive informalities.
d. Reviewing of minority business requirements at Preconstruction conference**.**
e. Monitoring of contractors' compliance with minority business requirements in the contract documents during construction.
f. Provide statistical data and required reports to the HUB Office.
g. Resolve any protest and disputes arising after implementation of the plan, in conjunction with the HUB Office.

3. Owner
Before awarding a contract, owner shall do the following:

a. Develop and implement a minority business participation outreach plan to identify minority businesses that can perform public building projects and to implement outreach efforts to encourage minority business participation in these projects to include education, recruitment, and interaction between minority businesses and non-minority businesses.
b. Attend the scheduled prebid conference.
c. At least 10 days prior to the scheduled day of bid opening, notify minority businesses that have requested notices from the public entity for public construction or repair work and minority businesses that otherwise indicated to the Office for Historically Underutilized Businesses an interest in the type of work being bid or the potential contracting opportunities listed in the proposal. The notification shall include the following:
    1. A description of the work for which the bid is being solicited.
    2. The date, time, and location where bids are to be submitted.
    3. The name of the individual within the owner's organization who will be available to answer questions about the project.
    4. Where bid documents may be reviewed.
    5. Any special requirements that may exist.
d. Utilize other media, as appropriate, likely to inform potential minority businesses of the bid being sought.
e. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
f. Review, jointly with the designer, all requirements of G.S. 143-128.2(c) and G.S. 143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with corresponding total dollar value of the bid and affidavit listing good faith efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award to the State Construction Office.
g. Evaluate documentation to determine good faith effort has been achieved for minority business utilization prior to recommendation of award to State Construction Office.
h. Review prime contractors' pay applications for compliance with minority business utilization commitments prior to payment**.**
i. Make documentation showing evidence of implementation of Owner's responsibilities available for review by State Construction Office and HUB Office, upon request

4. Designer
Under the single-prime bidding, separate prime bidding, construction manager at risk, or alternative contracting method, the designer will:

a. Attend the scheduled prebid conference to explain minority business requirements to the prospective bidders.
b. Assist the owner to identify and notify prospective minority business prime and subcontractors of potential contracting opportunities.
c. Maintain documentation of any contacts, correspondence, or conversation with minority business firms made in an attempt to meet the goals.
d. Review jointly with the owner, all requirements of G.S. 143-128.2(c) and G.S.143-128.2(f) – (i.e. bidders' proposals for identification of the minority businesses that will be utilized with

corresponding total dollar value of the bid and affidavit listing Good Faith Efforts, or affidavit of self-performance of work, if the contractor will perform work under contract by its own workforce) - prior to recommendation of award.

e. During construction phase of the project, review "MBE Documentation for Contract Payment" – (Appendix E) for compliance with minority business utilization commitments. Submit Appendix E form with monthly pay applications to the owner and forward copies to the State Construction Office.
f. Make documentation showing evidence of implementation of Designer's responsibilities available for review by State Construction Office and HUB Office, upon request.

5. Prime Contractor(s), CM at Risk, and Its First-Tier Subcontractors
Under the single-prime bidding, the separate-prime biding, construction manager at risk and alternative contracting methods, contractor(s) will:

a. Attend the scheduled prebid conference.
b. Identify or determine those work areas of a subcontract where minority businesses may have an interest in performing subcontract work.
c. At least ten (10) days prior to the scheduled day of bid opening, notify minority businesses of potential subcontracting opportunities listed in the proposal. The notification will include the following:
   (1) A description of the work for which the subbid is being solicited.
   (2) The date, time and location where subbids are to be submitted.
   (3) The name of the individual within the company who will be available to answer questions about the project.
   (4) Where bid documents may be reviewed.
   (5) Any special requirements that may exist, such as insurance, licenses, bonds and financial arrangements.

   If there are more than three (3) minority businesses in the general locality of the project who offer similar contracting or subcontracting services in the specific trade, the contractor(s) shall notify three (3), but may contact more, if the contractor(s) so desires.
d. During the bidding process, comply with the contractor(s) requirements listed in the proposal for minority participation.
e. Identify on the bid**,** the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).
f. Make documentation showing evidence of implementation of PM, CM-at-Risk and First-Tier Subcontractor responsibilities available for review by State Construction Office and HUB Office, upon request.
g. Upon being named the apparent low bidder, the Bidder shall provide one of the following: (1) an affidavit (Affidavit C) that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal; (2) if the percentage is not equal to the applicable goal, then documentation of all good faith efforts taken to meet the goal. Failure to comply with these requirements is grounds for rejection of the bid and award to the next lowest responsible and responsive bidder.
h. The contractor(s) shall identify the name(s) of minority business subcontractor(s) and corresponding dollar amount of work on the schedule of values. The schedule of values shall be provided as required in Article 31 of the General Conditions of the Contract to facilitate payments to the subcontractors.
i. The contractor(s) shall submit with each monthly pay request(s) and final payment(s), "MBE Documentation for Contract Payment" – (Appendix E), for designer's review.
j. During the construction of a project, at any time**,** if it becomes necessary to replace a minority business subcontractor, immediately advise the owner, State Construction Office, and the Director of the HUB Office in writing**,** of the circumstances involved. The prime contractor shall make a good faith effort to replace a minority business subcontractor with another minority business subcontractor.

k. If during the construction of a project additional subcontracting opportunities become available, make a good faith effort to solicit subbids from minority businesses.
l. It is the intent of these requirements apply to all contractors performing as prime contractor and first tier subcontractor under construction manager at risk on state projects.

6. Minority Business Responsibilities
While minority businesses are not required to become certified in order to participate in the State construction projects, it is recommended that they become certified and should take advantage of the appropriate technical assistance that is made available. In addition, minority businesses who are contacted by owners or bidders must respond promptly whether or not they wish to submit a bid.

SECTION 4: DISPUTE PROCEDURES
It is the policy of this state that disputes that involves a person's rights, duties or privileges, should be settled through informal procedures. To that end, minority business disputes arising under these guidelines should be resolved as governed under G.S. 143-128(g).

SECTION 5: These guidelines shall apply upon promulgation on state construction projects. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: www.nc-sco.com

SECTION 6: In addition to these guidelines, there will be issued with each construction bid package provisions for contractual compliance providing minority business participation in the state construction program.

MINORITY BUSINESS CONTRACT PROVISIONS (CONSTRUCTION)

APPLICATION:

The **Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts** are hereby made a part of these contract documents. These guidelines shall apply to all contractors regardless of ownership. Copies of these guidelines may be obtained from the Department of Administration, State Construction Office, (physical address) 301 North Wilmington Street, Suite 450, NC Education Building, Raleigh, North Carolina, 27601-2827, (mail address) 1307 Mail Service Center, Raleigh, North Carolina, 27699-1307, phone (919) 807-4100, Website: http://www.nc-sco.com

MINORITY BUSINESS SUBCONTRACT GOALS:

The goals for participation by minority firms as subcontractors on this project have been set at 10%.

The bidder must identify on its bid, the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit (Affidavit A) listing good faith efforts **or** affidavit (Affidavit B) of self-performance of work, if the bidder will perform work under contract by its own workforce, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f).

The lowest responsible, responsive bidder must provide Affidavit C, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal.

OR

Provide Affidavit D, that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, **with documentation of Good Faith Effort, if the percentage is not equal to the applicable goal.**

OR

Provide Affidavit B, which includes sufficient information for the State to determine that the bidder does not customarily subcontract work on this type project.

The above information must be provided as required. Failure to submit these documents is grounds for rejection of the bid.

MINIMUM COMPLIANCE REQUIREMENTS:

All written statements, affidavits or intentions made by the Bidder shall become a part of the agreement between the Contractor and the State for performance of this contract. Failure to comply with any of these statements, affidavits or intentions, or with the minority business Guidelines shall constitute a breach of the contract. A finding by the State that any information submitted either prior to award of the contract or during the performance of the contract is inaccurate, false or incomplete, shall also constitute a breach of the contract. Any such breach may result in termination of the contract in accordance with the termination provisions contained in the contract. It shall be solely at the option of the State whether to terminate the contract for breach.

In determining whether a contractor has made Good Faith Efforts, the State will evaluate all efforts made by the Contractor and will determine compliance in regard to quantity, intensity, and results of these efforts. Good Faith Efforts include:

(1) Contacting minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor or available on State or local government maintained lists at least 10 days before the bid or proposal date and notifying them of the nature and scope of the work to be performed.

(2) Making the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bid or proposals are due.

(3) Breaking down or combining elements of work into economically feasible units to facilitate minority participation.

(4) Working with minority trade, community, or contractor organizations identified by the Office for Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.

(5) Attending any prebid meetings scheduled by the public owner.

(6) Providing assistance in getting required bonding or insurance or providing alternatives to bonding or insurance for subcontractors.

(7) Negotiating in good faith with interested minority businesses and not rejecting them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.

(8) Providing assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisting minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.

(9) Negotiating joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.

(10) Providing quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

APPENDIX E

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

The following is a list of payments made to Minority Business Enterprises on this project for the above-mentioned period.

MBE FIRM NAME	* INDICATE TYPE OF MBE	AMOUNT PAID THIS MONTH	TOTAL PAYMENTS TO DATE	TOTAL AMOUNT COMMITTED

*Minority categories: Black, African American (B), Hispanic (H), Asian American (A), American Indian (I), Female (F), Social and Economically Disadvantage (D)

Date: _____ Approved/Certified By: _____
Name

_____
Title

_____
Signature

SUBMIT WITH EACH PAY REQUEST & FINAL PAYMENT

(Revised on 3/14/2003)

SECTION 00 72 00 - GENERAL CONDITIONS

FORM OF GENERAL CONDITIONS

1.01 THE GENERAL CONDITIONS APPLICABLE TO THIS CONTRACT IS ATTACHED FOLLOWING THIS PAGE.

RELATED REQUIREMENTS

2.01 SECTION 00 73 00 - SUPPLEMENTARY CONDITIONS.

SUPPLEMENTARY CONDITIONS

3.01 REFER TO DOCUMENT 00 73 00 - SUPPLEMENTARY CONDITIONS FOR AMENDMENTS TO THESE GENERAL CONDITIONS.

END OF SECTION

INSTRUCTIONS TO BIDDERS

AND

GENERAL CONDITIONS OF THE CONTRACT

STANDARD FORM FOR CONSTRUCTION PROJECTS

STATE CONSTRUCTION OFFICE

NORTH CAROLINA

DEPARTMENT OF ADMINISTRATION

Form OC-15

This document is intended for use on State capital construction projects and shall not be used on any project that is not reviewed and approved by the State Construction Office. Extensive modification to the General Conditions by means of "Supplementary General Conditions" is strongly discouraged. State agencies and institutions may include special requirements in "Division 1 – General Requirements" of the specifications, where they do not conflict with the General Conditions.

Twenty Fourth Edition January 2013

INSTRUCTIONS TO BIDDERS

For a proposal to be considered it must be in accordance with the following instructions:

1. **PROPOSALS**

Proposals must be made in strict accordance with the Form of Proposal provided therefor, and all blank spaces for bids, alternates, and unit prices applicable to bidder's work shall be properly filled in. When requested alternates are not bid, the proposer shall so indicate by the words "No Bid". Any blanks shall also be interpreted as "No Bid".The bidder agrees that bid on Form of Proposal detached from specifications will be considered and will have the same force and effect as if attached thereto. Photocopied or faxed proposals will not be considered. Numbers shall be stated both in writing and in figures for the base bids and alternates. If figures and writing differ, the written number will supersede the figures.

Any modifications to the Form of Proposal (including alternates and/or unit prices) will disqualify the bid and may cause the bid to be rejected.

The bidder shall fill in the Form of Proposal as follows:

a. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.

b. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

c. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.

d. If the proposal is made by a joint venture, it shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable.

e. All signatures shall be properly witnessed.

f. If the contractor's license of a bidder is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the proposal. The title "Licensee" shall appear under his/her signature.

Proposals should be addressed as indicated in the Advertisement for Bids and be delivered, enclosed in an opaque sealed envelope, marked "Proposal" and bearing the title of the work, name of the bidder, and the contractor's license number of the bidder. Bidders should clearly mark on the outside of the bid envelope which contract(s) they are bidding.

Bidder shall identify on the bid**,** the minority businesses that will be utilized on the project with corresponding total dollar value of the bid and affidavit listing good faith efforts or an affidavit indicating work under contract will be self-performed, as required by G.S. 143-128.2(c) and G.S. 143-128.2(f). Failure to comply with these requirements is grounds for rejection of the bid.

For projects bid in the single-prime alternative, the names and license numbers of major subcontractors shall be listed on the proposal form.

It shall be the specific responsibility of the bidder to deliver his bid to the proper official at the selected place and prior to the announced time for the opening of bids. Later delivery of a bid for any reason, including delivery by any delivery service, shall disqualify the bid.

Unit prices quoted in the proposal shall include overhead and profit and shall be the full compensation for the contractor's cost involved in the work. See General Conditions, Article 19c-1.

2. EXAMINATION OF CONDITIONS

It is understood and mutually agreed that by submitting a bid the bidder acknowledges that he has carefully examined all documents pertaining to the work, the location, accessibility and general character of the site of the work and all existing buildings and structures within and adjacent to the site, and has satisfied himself as to the nature of the work, the condition of existing buildings and structures, the conformation of the ground, the character, quality and quantity of the material to be encountered, the character of the equipment, machinery, plant and any other facilities needed preliminary to and during prosecution of the work, the general and local conditions, the construction hazards, and all other matters, including, but not limited to, the labor situation which can in any way affect the work under the contract, and including all safety measures required by the Occupational Safety and Health Act of 1970 and all rules and regulations issued pursuant thereto. It is further mutually agreed that by submitting a proposal the bidder acknowledges that he has satisfied himself as to the feasibility and meaning of the plans, drawings, specifications and other contract documents for the construction of the work and that he accepts all the terms, conditions and stipulations contained therein; and that he is prepared to work in cooperation with other contractors performing work on the site.

Reference is made to contract documents for the identification of those surveys and investigation reports of subsurface or latent physical conditions at the site or otherwise affecting performance of the work which have been relied upon by the designer in preparing the documents. The owner will make copies of all such surveys and reports available to the bidder upon request.

Each bidder may, at his own expense, make such additional surveys and investigations as he may deem necessary to determine his bid price for the performance of the work. Any on-site investigation shall be done at the convenience of the owner. Any reasonable request for access to the site will be honored by the owner.

3. BULLETINS AND ADDENDA

Any addenda to specifications issued during the time of bidding are to be considered covered in the proposal and in closing a contract they will become a part thereof. It shall be the bidder’s responsibility to ascertain prior to bid time the addenda issued and to see that his bid includes any changes thereby required.

Should the bidder find discrepancies in, or omission from, the drawings or documents or should he be in doubt as to their meaning, he shall at once notify the designer who will send written instructions in the form of addenda to all bidders. Notification should be no later than seven (7) days prior to the date set for receipt of bids. Neither the owner nor the designer will be responsible for any oral instructions.

All addenda should be acknowledged by the bidder(s) on the Form of Proposal. However, even if not acknowledged, by submitting a bid, the bidder has certified that he has reviewed all issued addenda and has included all costs associated within his bid.

4. **BID SECURITY**

Each proposal shall be accompanied by a cash deposit or a certified check drawn on some bank or trust company insured by the Federal Deposit Insurance Corporation, or a bid bond in an amount equal to not less than five percent (5%) of the proposal, said deposit to be retained by the owner as liquidated damages in event of failure of the successful bidder to execute the contract within ten (10) days after the award or to give satisfactory surety as required by law (G.S. 143-129).

Bid bond shall be conditioned that the surety will, upon demand, forthwith make payment to the obligee upon said bond if the bidder fails to execute the contract. The owner may retain bid securities of any bidder(s) who may have a reasonable chance of award of contract for the full duration of time stated in the Notice to Bidders. Other bid securities may be released sooner, at the discretion of the owner. All bid securities (cash or certified checks) shall be returned to the bidders promptly after award of contracts, and no later then seven (7) days after expiration of the holding period stated in the Notice to Bidders. Standard Form of Bid Bond is included in these specifications and shall be used.

5. **RECEIPT OF BIDS**

Bids shall be received in strict accordance with requirements of the General Statutes of North Carolina. Bid security shall be required as prescribed by statute. Prior to the closing of the bid, the bidder will be permitted to change or withdraw his bid. Guidelines for opening of public construction bids are available from the State Construction Office.

6. **OPENING OF BIDS**

Upon opening, all bids shall be read aloud. Once bidding is closed, there shall not be any withdrawal of bids by any bidder and no bids may be returned by the designer to any bidder. After the opening of bids, no bid may be withdrawn, except under the provisions of General Statute 143-129.1, for a period of thirty days unless otherwise specified. Should the successful bidder default and fail to execute a contract, the contract may be awarded to the next lowest and responsible bidder. The owner reserves the unqualified right to reject any and all bids. Reasons for rejection may include, but shall not be limited to, the following:

a. If the Form of Proposal furnished to the bidder is not used or is altered.

b. If the bidder fails to insert a price for all bid items, alternate and unit prices requested.

c. If the bidder adds any provisions reserving the right to accept or reject any award.

d. If there are unauthorized additions or conditional bids, or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.

e. If the bidder fails to complete the proposal form where information is requested so the bid may be properly evaluated by the owner.

f. If the unit prices contained in the bid schedule are unacceptable to the owner and the State Construction Office.

g. If the bidder fails to comply with other instructions stated herein.

7. **BID EVALUATION**

The award of the contract will be made to the lowest responsible bidder as soon as practical. The owner may award on the basis of the base bid and any alternates the owner chooses.

Before awarding a contract, the owner may require the apparent low bidder to qualify himself to be a responsible bidder by furnishing any or all of the following data:

a. The latest financial statement showing assets and liabilities of the company or other information satisfactory to the owner.

b. A listing of completed projects of similar size.

c. Permanent name and address of place of business.

d. The number of regular employees of the organization and length of time the organization has been in business under present name.

e. The name and home office address of the surety proposed and the name and address of the responsible local claim agent.

f. The names of members of the firms who hold appropriate trade licenses, together with license numbers.

g. If prequalified, contractor info will be reviewed and evaluated comparatively to submitted prequalification package.

Failure or refusal to furnish any of the above information, if requested, shall constitute a basis for disqualification of any bidder.

In determining the lowest responsible, responsive bidder, the owner shall take into consideration the bidder's compliance with the requirements of G.S. 143-128.2(c), the past performance of the bidder on construction contracts for the State with particular concern given to completion times, quality of work, cooperation with other contractors, and cooperation with the designer and owner. Failure of the low bidder to furnish affidavit and/or documentation as required by G.S. 143-128.2(c) shall constitute a basis for disqualification of the bid.

Should the owner adjudge that the apparent low bidder is not the lowest responsible, responsive bidder by virtue of the above information, said apparent low bidder will be so notified and his bid security shall be returned to him.

8. **PERFORMANCE BOND**

The successful bidder, upon award of contract, shall furnish a performance bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

9. **PAYMENT BOND**

The successful bidder, upon award of contract, shall furnish a payment bond in an amount equal to 100 percent of the contract price. See Article 35, General Conditions.

10. **PAYMENTS**

Payments to the successful bidders (contractors) will be made on the basis of monthly estimates. See Article 31, General Conditions.

11. **PRE-BID CONFERENCE**

Prior to the date set for receiving bids, the Designer may arrange and conduct a Pre-Bid Conference for all prospective bidders. The purpose of this conference is to review project requirements and to respond to questions from prospective bidders and their subcontractors or material suppliers related to the intent of bid documents. Attendance by prospective bidders shall be as required by the "Notice to Bidders".

12. **SUBSTITUTIONS**

In accordance with the provisions of G.S. 133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until ten (10) days prior to the receipt of bids when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

Submittals for proposed substitutions shall include the following information:

a. Name, address, and telephone number of manufacturer and supplier as appropriate.

b. Trade name, model or catalog designation.

c. Product data including performance and test data, reference standards, and technical descriptions of material, product, or equipment. Include color samples and samples of available finishes as appropriate.

d. Detailed comparison with specified products including performance capabilities, warranties, and test results.

e. Other pertinent data including data requested by the Designer to confirm product equality.

If a proposed material, product, or equipment substitution is deemed equal by the Designer to those specified, all bidders of record will be notified by Addendum**.**

GENERAL CONDITIONS OF THE CONTRACT

TABLE OF CONTENTS

ARTICLE 1 - DEFINITIONS

a. The **contract documents** consist of the Notice to Bidders; Instructions to Bidders; General Conditions of the Contract; special conditions if applicable; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the proposal; the contract; the performance bond; the payment bond; insurance certificates; the approval of the attorney general; and the certificate of the Office of State Budget and Management. All of these items together form the contract.

b. The **owner** is the State of North Carolina through the agency named in the contract.

c. The **designer(s)** are those referred to within this contract, or their authorized representatives. The Designer(s), as referred to herein, shall mean architect and/or engineer. They will be referred to hereinafter as if each were of the singular number, masculine gender.

d. The **contractor**, as referred to hereinafter, shall be deemed to be either of the several contracting parties called the "Party of the First Part" in either of the several contracts in connection with the total project. Where, in special instances hereinafter, a particular contractor is intended, an adjective precedes the word "contractor," as "general," "heating," etc. For the purposes of a single prime contract, the term Contractor shall be deemed to be the single contracting entity identified as the “Party of the First Part” in the single Construction Contract. Any references or adjectives that name or infer multiple prime contractors shall be interpreted to mean the single prime Contractor.

e. A **subcontractor**, as the term is used herein, shall be understood to be one who has entered into a direct contract with a contractor, and includes one who furnishes materials worked to a special design in accordance with plans and specifications covered by the contract, but does not include one who only sells or furnishes materials not requiring work so described or detailed.

f. **Written notice** shall be defined as notice in writing delivered in person to the contractor, or to a partner of the firm in the case of a partnership, or to a member of the contracting organization, or to an officer of the organization in the case of a corporation, or sent to the last known business address of the contracting organization by registered mail.

g. **Work**, as used herein as a noun, is intended to include materials, labor, and workmanship of the appropriate contractor.

h. The **project** is the total construction work to be performed under the contract documents by the several contractors.

i. **Project Expediter,** as used herein, is an entity stated in the contract documents, designated to effectively facilitate scheduling and coordination of work activities. See Article 14(f) for responsibilities of a Project Expediter. **For the purposes of a single prime contract, the single prime contractor shall be designated as the Project Expediter.**

j. **Change order**, as used herein, shall mean a written order to the contractor subsequent to the signing of the contract authorizing a change in the contract. The change order shall be signed by the contractor, designer and the owner, and approved by the State Construction Office, in that order (Article 19).

k. **Field Order,** as used herein, shall mean a written approval for the contractor to proceed with the work requested by owner prior to issuance of a formal Change Order. The field order shall be signed by the contractor, designer, owner, and State Construction Office.

l. **Time of completion**, as stated in the contract documents, is to be interpreted as consecutive calendar days measured from the date established in the written Notice to Proceed, or such other date as may be established herein (Article 23).

m. **Liquidated damages,** as stated in the contract documents [, is an amount reasonably estimated in advance to cover the consequential damages associated with the Owner's economic loss in not being able to use the Project for its intended purposes at the end of the contract's completion date as amended by change order, if any, by reason of failure of the contractor(s) to complete the work within the time specified. Liquidated damages does not include the Owner's extended contract administration costs (including but not limited to additional fees for architectural and engineering services, testing services, inspection services, commissioning services, etc.), such other damages directly resulting from delays caused solely by the contractor, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused soley by the Contractor (e.g., if a multi-phased project-subsequent phases, delays in start other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).

n. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the contractor, and which engages to be responsible for the contractor and his acceptable performance of the work.

o. **Routine written communications between the Designer and the Contractor** are any communication other than a "request for information" provided in letter, memo, or transmittal format, sent by mail, courier, electronic mail, or facsimile. Such communications can not be identified as "request for information".

p. **Clarification or Request for information (RFI)** is a request from the Contractor seeking an interpretation or clarification by the Designer relative to the contract documents. The RFI, which shall be labeled (RFI), shall clearly and concisely set forth the issue or item requiring clarification or interpretation and why the response is needed. The RFI must set forth the Contractor's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.

q. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work**.**

r. **Inspection** shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.

s. **"Equal to" or "approved equal"** shall mean materials, products, equipment, assemblies, or installation methods considered equal by the bidder in all characteristics (physical, functional, and aesthetic) to those specified in the contract documents. Acceptance of equal is subject to approval of Designer and owner.

t. **"Substitution" or "substitute"** shall mean materials, products, equipment, assemblies, or installation methods deviating in at least one characteristic (physical, functional, or aesthetic) from those specified, but which in the opinion of the bidder would improve competition and/or enhance the finished installation. Acceptance of substitution is subject to the approval of the Designer and owner.

u. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.

v. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.

w. **Special inspector** is one who inspects materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the approved construction documents and referenced standards.

x. **Commissioning** is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents.

y. **Designer Final Inspection** is the inspection performed by the design team to determine the completeness of the project in accordance with approved plans and specifications. This inspection occurs prior to SCO final inspection.

z. **SCO Final Inspection** is the inspection performed by the State Construction Office to determine the completeness of the project in accordance with NC Building Codes and approved plans and specifications.

aa. **Beneficial Occupancy** is requested by the owner and is occupancy or partial occupancy of the building after all life safety items have been completed as determined by the State Construction Office. Life safety items include but not limited to fire alarm, sprinkler, egress and exit lighting, fire rated walls, egress paths and security.

bb. Final Acceptance is the date in which the State Construction Office accepts the construction as totally complete. This includes the SCO Final Inspection and certification by the designer that all punch lists are completed.

ARTICLE 2 - INTENT AND EXECUTION OF DOCUMENTS

a. The drawings and specifications are complementary, one to the other, and that which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a bid for a complete job. In case of discrepancy or disagreement in the contract documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.

b. The wording of the specifications shall be interpreted in accordance with common usage of the language except that words having a commonly used technical or trade meaning shall be so interpreted in preference to other meanings.

c. The contractor shall execute each copy of the proposal, contract, performance bond and payment bond as follows:

1. If the documents are executed by a sole owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.

2. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

3. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.

4. If the documents are made by a joint venture, they shall be executed by each member of the joint venture in the above form for sole owner, partnership or corporation, whichever form is applicable to each particular member.

5. All signatures shall be properly witnessed.

6. If the contractor's license is held by a person other than an owner, partner or officer of a firm, then the licensee shall also sign and be a party to the contract. The title "Licensee" shall appear under his/her signature.

7. The bonds shall be executed by an attorney-in-fact. There shall be attached to each copy of the bond a certified copy of power of attorney properly executed and dated.

8. Each copy of the bonds shall be countersigned by an authorized individual agent of the bonding company licensed to do business in North Carolina. The title "Licensed Resident Agent" shall appear after the signature.

9. The seal of the bonding company shall be impressed on each signature page of the bonds.

10. The contractor's signature on the performance bond and the payment bond shall correspond with that on the contract. The date of performance and payment bond shall not be prior to the date of the contract.

ARTICLE 3 - CLARIFICATIONS AND DETAIL DRAWINGS

a. In such cases where the nature of the work requires clarification by the designer, such clarification shall be furnished by the designer with reasonable promptness by means of written instructions or detail drawings, or both. Clarifications and drawings shall be consistent with the intent of contract documents, and shall become a part thereof.

b. The contractor(s) and the designer shall prepare, if deemed necessary, a schedule fixing dates upon which foreseeable clarifications will be required. The schedule will be subject to addition or change in accordance with progress of the work. The designer shall furnish drawings or clarifications in accordance with that schedule. The contractor shall not proceed with the work without such detail drawings and/or written clarifications.

ARTICLE 4 - COPIES OF DRAWINGS AND SPECIFICATIONS

The designer or Owner shall furnish free of charge to the contractors electronic copies of plans and specifications. If requested by the contractor, paper copies of plans and specifications shall be furnished free of charge as follows:

a. General contractor - Up to twelve (12) sets of general contractor drawings and specifications, up to six (6) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

b. Each other contractor - Up to six (6) sets of the appropriate drawings and specifications, up to three (3) sets of which shall include drawings and specifications of all other contracts, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

c. Additional sets shall be furnished at cost, including mailing, to the contractor upon request by the contractor. This cost shall be stated in the bidding documents.

d. For the purposes of a single-prime contract, the contractor shall receive up to 30 sets of drawings and specifications, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the contractor shall clearly and legibly record all work-in-place that is at variance with the contract documents.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

a. Within 15 consecutive calendar days after the notice to proceed, each prime contractor shall submit a schedule for submission of all shop drawings, product data, samples, and similar submittals through the Project Expediter to the Designer. This schedule shall indicate the items, relevant specification sections, other related submittal, data, and the date when these items will be furnished to the designer.

b. The Contractor(s) shall review, approve and submit to the Designer all Shop Drawings, Coordination Drawings, Product Data, Samples, Color Charts, and similar submittal data required or reasonably implied by the Contract Documents. Required Submittals shall bear the Contractor's stamp of approval, any exceptions to the Contract Documents shall be noted on the submittals, and copies of all submittals shall be of sufficient quantity for the Designer to retain up to three (3) copies of each submittal for his own use plus additional copies as may be required by the Contractor. Submittals shall be presented to the Designer in accordance with the schedule submitted in paragraph (a). so as to cause no delay in the activities of the Owner or of separate Contractors.

c. The Designer shall review required submittals promptly, noting desired corrections if any, and retaining three (3) copies (1 for the Designer, 1 for the owner and 1 for SCO) for his use. The remaining copies of each submittal shall be returned to the Contractor not later than twenty (20) days from the date of receipt by the Designer, for the Contractor's use or for corrections and resubmittal as noted by the Designer. When resubmittals are required, the submittal procedure shall be the same as for the original submittal**s.**

d. Approval of shop drawings/submittals by the Designer shall not be construed as relieving the Contractor from responsibility for compliance with the design or terms of the contract documents nor from responsibility of errors of any sort in the shop drawings, unless such lack of compliance or errors first have been called in writing to the attention of the Designer by the Contractor.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

a. The contractor shall maintain, in readable condition at his job office, one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the designer, his authorized representative, owner or State Construction Office.

b. The contractor shall maintain at the job office, a day-to-day record of work-in-place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the contractor and submitted to the designer upon project completion and no later than 30 days after final acceptance of the project.

c. The contractor shall maintain at the job office a record of all required tests that have been performed, clearly indicating the scope of work inspected and the date of approval or rejection.

ARTICLE 7 - OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All drawings and specifications are instruments of service and remain the property of the owner. The use of these instruments on work other than this contract without permission of the owner is prohibited. All copies of drawings and specifications other than contract copies shall be returned to the owner upon request after completion of the work.

ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

a. The contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, heat, sanitary facilities, water, scaffolding and incidentals necessary for the completion of his work, and shall install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same, and shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied therefrom, all in accordance with the contract documents.

b. All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.

c. Upon notice, the contractor shall furnish evidence as to quality of materials.

d. Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Request for substitution of materials, items, or equipment shall be submitted to the designer for approval or disapproval; such approval or disapproval shall be made by the designer prior to the opening of bids. Alternate materials may be requested after the award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and owner approves.

e. The designer is the judge of equality for proposed substitution of products, materials or equipment.

g. If at any time during the construction and completion of the work covered by these contract documents, the language, conduct, or attire of any workman of the various crafts be adjudged a nuisance to the owner or designer, or if any workman be considered detrimental to the work, the contractor shall order such parties removed immediately from grounds.

ARTICLE 9 - ROYALTIES, LICENSES AND PATENTS

It is the intention of the contract documents that the work covered herein will not constitute in any way infringement of any patent whatsoever unless the fact of such patent is clearly evidenced herein. The contractor shall protect and save harmless the owner against suit on account of alleged or actual infringement. The contractor shall pay all royalties and/or license fees required on account of patented articles or processes, whether the patent rights are evidenced hereinafter.

ARTICLE 10 - PERMITS, INSPECTIONS, FEES, REGULATIONS

a. The contractor shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the contractor observes that the drawings and specifications are at variance therewith, he shall promptly notify the designer in writing. See Instructions to Bidders, Paragraph 3, Bulletins and Addenda. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the designer, he shall bear all cost arising therefrom. Additional requirements implemented after bidding will be subject to equitable negotiations.

b. All work under this contract shall conform to the North Carolina State Building Code and other State, local and national codes as are applicable. The cost of all required inspections and permits shall be the responsibility of the contractor and included within the bid proposal. All water taps, meter barrels, vaults and impact fees shall be paid by the contractor unless otherwise noted.

d. Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to inspection by any county or municipal authorities and are not subject to county or municipal building codes. The contractor shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.

e. Projects involving local funding (community colleges) are subject also to county and municipal building codes and inspection by local authorities. The contractor shall pay the cost of these permits and inspections.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

a. The contractors shall be jointly responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the owner or designer, and by laws or ordinances governing such conditions. They shall be responsible for any damage to the owner's property, or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. They shall be responsible for and pay for any damages caused to the owner. All contractors shall have access to the project at all times.

b. The contractor shall provide cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building, whether set by him, or any of the subcontractors. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the owner.

c. No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the designer and owner.

d. The contractor shall protect all trees and shrubs designated to remain in the vicinity of the operations by building substantial boxes around same. He shall barricade all walks, roads, etc., as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.

e. The contractor shall provide all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. He shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. He shall protect against damage or injury resulting from falling materials and he shall maintain all protective devices and signs throughout the progress of the work.

f. The contractor shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by General Statutes of North Carolina 95-126 through 155.

g. The contractor shall designate a responsible person of his organization as safety officer/inspector to inspect the project site for unsafe health and safety hazards, to report these hazards to the contractor for correction, and whose duties also include accident prevention on the project, and to provide other safety and health measures on the project site as required by the terms and conditions of the contract.The name of the safety inspector shall be made known to the designer and owner at the time of the preconstruction conference and in all cases prior to any work starting on the project.

h. In the event of emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the contractor is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such threatened injury or damage.

Any compensation claimed by the contractor on account of such action shall be determined as provided for under Article 19(b).

i. Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

ARTICLE 12 - SEDIMENTATION POLLUTION CONTROL ACT OF 1973

a. Any land-disturbing activity performed by the contractor(s) in connection with the project shall comply with all erosion control measures set forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).

b. Upon receipt of notice that a land-disturbing activity is in violation of said act, the contractor(s) shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.

c. The contractor(s) shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.

d. To the fullest extent permitted by law, the contractor(s) shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

ARTICLE 13 - INSPECTION OF THE WORK

a. It is a condition of this contract that the work shall be subject to inspection during normal working hours and during any time work is in preparation and progress by the designer, designated official representatives of the owner, State Construction Office and those persons required by state law to test special work for official approval. The contractor shall therefore provide safe access to the work at all times for such inspections.

b. All instructions to the contractor will be made only by or through the designer or his designated project representative. Observations made by official representatives of the owner shall be conveyed to the designer for review and coordination prior to issuance to the contractor.

c. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. Contractor shall give a minimum two weeks notice unless otherwise agreed to by all parties. If inspection fails, after the first reinspection all costs associated with additional reinspections shall be borne by the contractor.

d. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the contractor shall give adequate notice to the designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the designer. Such special tests or inspections will be made in the presence of the designer, or his authorized representative, and it shall be the contractor's responsibility to serve ample notice of such tests.

e. All laboratory tests shall be paid by the owner unless provided otherwise in the contract documents except the general contractor shall pay for laboratory tests to establish design mix for concrete, and for additional tests to prove compliance with contract documents where materials have tested deficient except when the testing laboratory did not follow the appropriate ASTM testing procedures.

f. Should any work be covered up or concealed prior to inspection and approval by the designer, special inspector, and/or State Construction Office such work shall be uncovered or exposed for inspection, if so requested by the designer in writing. Inspection of the work will be made upon notice from the contractor. All cost involved in uncovering, repairing, replacing, recovering and restoring to design condition, the work that has been covered or concealed will be paid by the contractor involved.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

a. Throughout the progress of the work, each contractor shall keep at the job site**,** a competent superintendent and supervisory staff satisfactory to the designer and the owner. The superintendent and supervisory staff shall not be changed without the consent of the designer and owner unless said superintendent ceases to be employed by the contractor or ceases to be competent as determined by the contractor, designer or owner. The superintendent and other staff designated by the contractor in writing shall have authority to act on behalf of the contractor, and instructions, directions or notices given to him shall be as binding as if given to the contractor. However, directions, instructions, and notices shall be confirmed in writing.

b. The contractor shall examine and study the drawings and specifications and fully understand the project design, and shall provide constant and efficient supervision to the work. Should he discover any discrepancies of any sort in the drawings or specifications, he shall report them to the designer without delay. He will not be held responsible for discrepancies in the drawings and/or specifications, but shall be held responsible to report them should they become known to him.

c. All contractors shall be required to cooperate and consult with each other during the construction of this project. Prior to installation of work, all contractors shall jointly prepare coordination drawings, showing locations of various ductworks, piping, motors, pumps, and other mechanical or electrical equipment, in relation to the structure, walls and ceilings. These drawings shall be submitted to the designer through the Project Expediter for information only**.** Each contractor shall lay out and execute his work to cause the least delay to other contractors. Each contractor shall be financially responsible for any damage to other contractor's work and for undue delay caused to other contractors on the project.

d. The contractor is required to attend job site progress conferences as called by the designer. The contractor shall be represented at these job progress conferences by both home office and project personnel. These representatives shall have authority to act on behalf of the contractor. These meetings shall be open to subcontractors, material

suppliers and any others who can contribute toward maintaining required job progress. It shall be the principal purpose of these meetings, or conferences, to effect coordination, cooperation and assistance in every practical way toward the end of maintaining progress of the project on schedule and to complete the project within the specified contract time. Each contractor shall be prepared to assess progress of the work as required in his particular contract and to recommend remedial measures for correction of progress as may be appropriate. The designer or his authorized representative shall be the coordinator of the conferences and shall preside as chairman. The contractor shall turn over a copy of his daily reports to the Designer and Owner at the job site progress conference. Owner will determine daily report format.

e The contractor(s) shall, employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a bench mark in a location where same will not be disturbed and where direct instruments sights may be taken.

f. The designer shall designate a Project Expediter on projects involving two or more prime contracts. The Project Expediter shall be designated in the Supplementary General Conditions. The Project Expediter shall have at a minimum the following responsibilities**.**

1. Prepare the project construction schedule and shall allow all prime contractors (multi-prime contract) and subcontractors (single-prime contract) performing general, plumbing, HVAC, and electrical work equal input into the preparation of the initial construction schedule.

2. Maintain a project progress schedule for all contractors.

3. Give adequate notice to all contractors to ensure efficient continuity of all phases of the work.

4. Notify the designer of any changes in the project schedule.

5. Recommend to the owner whether payment to a contractor shall be approved**.**

g. It shall be the responsibility of the Project Expediter to cooperate with and obtain from several prime contractors and subcontractors on the job, their respective work activities and integrate these activities into a project construction schedule in form of a detailed bar chart or Critical Path Method (CPM), schedule. Each prime contractor shall provide work activities within fourteen (14) days of request by the Project Expediter. A "work activity", for scheduling purposes, shall be any component or contractual requirement of the project requiring at least one (1) day, but not more than fourteen (14) days, to complete or fulfill**.** The project construction schedule shall graphically show all salient features of the work required to construct the project from start to finish and within the allotted time established in the contract. The time (in days) between the contractor's early completion and contractual completion dates is part of the project total float time; and shall be used as such, unless amended by a change order**.** On a multi-prime project, each prime contractor shall review the proposed construction schedule and approve same in writing**.** The Project Expediter shall submit the proposed construction schedule to the designer for comments. The complete Project construction schedule shall be of the type set forth in the Supplementary General Condition or subparagraph (1) or (2) below, as appropriate:

1. For a project with total contracts of $500,000 or less, a bar chart schedule will satisfy the above requirement. The schedule shall indicate the estimated starting and completion dates for each major element of the work.

2. For a project with total contracts over $500,000, a Critical Path Method (CPM) schedule shall be utilized to control the planning and scheduling of the Work. The CPM schedule shall be the responsibility of the Project Expediter and shall be paid for by the Project Expediter.

Bar Chart Schedule: Where a bar chart schedule is required, it shall be time-scaled in weekly increments, shall indicate the estimated starting and completion dates for each major element of the work by trade and by area, level, or zone, and shall schedule dates for all salient features, including but not limited to the placing of orders for materials, submission of shop drawings and other Submittals for approval, approval of shop drawings by designers, the manufacture and delivery of material, the testing and the installation of materials, supplies and equipment, and all Work activities to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s). Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

CPM Schedule: Where a CPM schedule is required, it shall be in time-scaled precedence format using the Project Expediter's logic and time estimates. The CPM schedule shall be drawn or plotted with activities grouped or zoned by Work area or subcontract as opposed to a random (or scattered) format. The CPM schedule shall be time-scaled on a weekly basis and shall be drawn or plotted at a level of detail and logic which will schedule all salient features of the work to be performed by the Contractor. The Contractor shall allow sufficient time in his schedule for all commissioning, required inspections and completion of final punchlist(s).. Each Work activity will be assigned a time estimate by the Contractor. One day shall be the smallest time unit used.

The CPM schedule will identify and describe each activity, state the duration of each activity, the calendar dates for the early and late start and the early and late finish of each activity, and clearly highlight all activities on the critical path. "Total float" and "free float" shall be indicated for all activities. Float time shall not be considered for the exclusive use or benefit of either the Owner or the Contractor, but must be allocated in the best interest of completing the Work within the Contract time. Extensions to the Contract time, when granted by Change Order, will be granted only when equitable time adjustment exceeds the Total Float in the activity or path of activities affected by the change. On contracts with a price over $2,500,000, the CPM schedule shall also show what part of the Contract Price is attributable to each activity on the schedule, the sum of which for all activities shall equal the total Contract Price.

Early Completion of Project: The Contractor may attempt to complete the project prior to the Contract Completion Date. However, such planned early completion shall be for the Contractor's convenience only and shall not create any additional rights of the Contractor or obligations of the Owner under this Contract, nor shall it change the Time

for Completion or the Contract Completion Date. The Contractor shall not be required to pay liquidated damages to the Owner because of its failure to complete by its planned earlier date. Likewise, the Owner shall not pay the Contractor any additional compensation for early completion nor will the Owner owe the Contractor any compensation should the Owner, its officers, employees, or agents cause the Contractor not to complete earlier than the date required by the Contract Documents.

h. The proposed project construction schedule shall be presented to the designer no later than fifteen (15) days after written notice to proceed. No application for payment will be processed until this schedule is accepted by the designer and owner.

i. The approved project construction schedule shall be distributed to all contractors and displayed at the job site by the Project Expediter.

j. The several contractors shall be responsible for their work activities and shall notify the Project Expediter of any necessary changes or adjustments to their work. The Project Expediter shall maintain the project construction schedule, making biweekly adjustments, updates, corrections, etc., that are necessary to finish the project within the Contract time, keeping all contractors and the designer fully informed. Copy of a bar chart schedule annotated to show the current progress shall be submitted by the Contractor(s) to the designer, along with monthly request for payment. For project requiring CPM schedule, the Contractor shall submit a biweekly report of the status of all activities. The bar chart schedule or status report shall show the actual Work completed to date in comparison with the original Work scheduled for all activities. If any activities of the work of several contractors are behind schedule, the contractor must indicate in writing, what measures will be taken to bring each such activity back on schedule and to ensure that the Contract Completion Date is not exceeded. A plan of action and recovery schedule shall be developed and submitted to the designer by the Project Expediter, when (1) the contractor's report indicates delays, that are in the opinion of the designer or the owner, of sufficient magnitude that the contractor's ability to complete the work by the scheduled completion is brought into question; (2) the updated construction schedule is thirty (30) days behind the planned or baseline schedule and no legitimate time extensions, as determined by the Designer, are in process; and (3) the contractor desires to make changes in the logic (sequencing of work) or the planned duration of future activities of the CPM schedule which, in the opinion of the designer or the owner, are of a major nature. The plan of action, when required shall be submitted to the Owner for review within two (2) business days of the Contractor receiving the Owner's written demand. The recovery schedule, when required, shall be submitted to the Owner within five (5) calendar days of the Contractor's receiving the Owner's written demand. Failure to provide an updated construction schedule or a recovery schedule may be grounds for rejection of payment applications or withholding of funds as set forth in Article 33.

k. The Project Expediter shall notify each contractor of such events or time frames that are critical to the progress of the job. Such notice shall be timely and reasonable. Should the progress be delayed due to the work of any of the several contractors, it shall be the duty of the Project Expediter to immediately notify the contractor(s) responsible for such delay, the designer, the State Construction Office and other prime contractors. The designer shall determine the contractor(s) who caused the delays and notify the bonding company of the responsible contractor(s) of the delays; and shall make a recommendation to the owner regarding further action.

l. Designation as Project Expediter entails an additional project control responsibility and does not alter in any way the responsibility of the contractor so designated, nor the

responsibility of the other contractors involved in the project. The project expeditor's Superintendent(s) shall be in attendance at the Project site at all times when work is in progress unless conditions are beyond the control of the Contractor or until termination of the Contract in accordance with the Contract Documents. It is understood that such Superintendent shall be acceptable to the Owner and Designer and shall be the one who will be continued in that capacity for the duration of the project unless he ceases to be on the Contractor's payroll or the Owner otherwise agrees. The Superintendent shall not be employed on any other project for or by the Contractor or by any other entity during the course of the Work. If the Superintendent is employed by the Contractor on another project without the Owner's approval, then the Owner may deduct from the Contractor's monthly general condition costs and amount representing the Superintendent's cost and shall deduct that amount for each month thereafter until the Contractor has the Superintendent back on the Owner's Project full-time.

ARTICLE 15 - SEPARATE CONTRACTS AND CONTRACTOR RELATIONSHIPS

a. Effective from January 1, 2002, Chapter 143, Article 8, was amended, to allow public contracts to be delivered by the following delivery methods: single-prime, dual (single-prime and separate-prime), construction manager at risk, and alternative contracting method as approved by the State Building Commission. The owner reserves the right to prepare separate specifications, receive separate bids, and award separate contracts for such other major items of work as may be in the best interest of the State. For the purposes of a single prime contract, refer to Article 1 – Definitions.

b. All contractors shall cooperate with each other in the execution of their work, and shall plan their work in such manner as to avoid conflicting schedules or delay of the work. See Article 14, Construction Supervision.

c. If any part of contractor's work depends upon the work of another contractor, defects which may affect that work shall be reported to the designer in order that prompt inspection may be made and the defects corrected. Commencement of work by a contractor where such condition exists will constitute acceptance of the other contractor's work as being satisfactory in all respects to receive the work commenced, except as to defects which may later develop. The designer shall be the judge as to the quality of work and shall settle all disputes on the matter between contractors.

d. Any mechanical or electrical work such as sleeves, inserts, chases, openings, penetrations, etc., which is located in the work of the general contractor shall be built in by the general contractor. The respective mechanical and electrical contractors shall set all sleeves, inserts and other devices that are to be incorporated into the structure in cooperation and under the supervision of the general contractor. The responsibility for the exact location of such items shall be that of the mechanical and/or electrical contractor.

e. The designer and the owner shall have access to the work whenever it is in preparation and progress and during normal working hours. The contractor shall provide facilities for such access so the designer may perform his functions under the contract documents.

f. Should a contractor cause damage to the work or property of another contractor, he shall be directly responsible, and upon notice, shall promptly settle the claim or otherwise resolve the dispute.

ARTICLE 16 - SUBCONTRACTS AND SUBCONTRACTORS

a. Within thirty (30) days after award of the contract, the contractor shall submit to the designer, owner and to the State Construction Office a list giving the names and addresses of subcontractors and equipment and material suppliers he proposes to use, together with the scope of their respective parts of the work. Should any subcontractor be disapproved by the designer or owner, the designer or owner shall submit his reasons for disapproval in writing to the State Construction Office for its consideration with a copy to the contractor. If the State Construction Office concurs with the designer's or owner's recommendation, the contractor shall submit a substitute for approval. The designer and owner shall act promptly in the approval of subcontractors, and when approval of the list is given, no changes of subcontractors will be permitted except for cause or reason considered justifiable by the designer or owner.

b. The designer will furnish to any subcontractor, upon request, evidence regarding amounts of money paid to the contractor on account of the subcontractor's work.

c. The contractor is and remains fully responsible for his own acts or omissions as well as those of any subcontractor or of any employee of either. The contractor agrees that no contractual relationship exists between the subcontractor and the owner in regard to the contract, and that the subcontractor acts on this work as an agent or employee of the contractor.

d. The owner reserves the right to limit the amount of portions of work to be subcontracted as hereinafter specified.

ARTICLE 17 - CONTRACTOR AND SUBCONTRACTOR RELATIONSHIPS

The contractor agrees that the terms of these contract documents shall apply equally to each subcontractor as to the contractor, and the contractor agrees to take such action as may be necessary to bind each subcontractor to these terms. The contractor further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to contractor-subcontractor relationships, and that payments to subcontractors shall be made in accordance with the provisions of G.S. 143-134.1 titled Interest on final payments due to prime contractors: payments to subcontractors.

a. On all public construction contracts which are let by a board or governing body of the state government or any political subdivision thereof, except contracts let by the Department of Transportation pursuant to G.S. 136-28.1, the balance due prime contractors shall be paid in full within 45 days after respective prime contracts of the project have been accepted by the owner, certified by the architect, engineer or designer to be completed in accordance with terms of the plans and specifications, or occupied by the owner and used for the purpose for which the project was constructed, whichever occurs first. Provided, however, that whenever the architect or consulting engineer in charge of the project determines that delay in completion of the project in accordance with terms of the plans and specifications is the fault of the contractor, the project may be occupied and used for the purposes for which it was constructed without payment of any interest on amounts withheld past the 45 day limit. No payment shall be delayed because of the failure of another prime contractor on such project to complete his contract. Should final payment to any prime contractor beyond the date such contracts have been certified to be completed by the designer or architect, accepted by the owner, or occupied by the owner and used for the purposes for which the project was constructed, be delayed by more than 45 days, said prime contractor shall be paid interest, beginning on the 46th day, at the rate of one percent (1%) per month or fraction thereof unless a lower rate is

agreed upon on such unpaid balance as may be due. In addition to the above final payment provisions, periodic payments due a prime contractor during construction shall be paid in accordance with the payment provisions of the contract documents or said prime contractor shall be paid interest on any such unpaid amount at the rate stipulated above for delayed final payments. Such interest shall begin on the date the payment is due and continue until the date on which payment is made. Such due date may be established by the terms of the contract. Funds for payment of such interest on state-owned projects shall be obtained from the current budget of the owning department, institution or agency. Where a conditional acceptance of a contract exists, and where the owner is retaining a reasonable sum pending correction of such conditions, interest on such reasonable sum shall not apply.

b. Within seven days of receipt by the prime contractor of each periodic or final payment, the prime contractor shall pay the subcontractor based on work completed or service provided under the subcontract. Should any periodic or final payment to the subcontractor be delayed by more than seven days after receipt of periodic or final payment by the prime contractor, the prime contractor shall pay the subcontractor interest, beginning on the eighth day, at the rate of one percent (1%) per month or fraction thereof on such unpaid balance as may be due.

c. The percentage of retainage on payments made by the prime contractor to the subcontractor shall not exceed the percentage of retainage on payments made by the owner to the prime contractor. Any percentage of retainage on payments made by the prime contractor to the subcontractor that exceeds the percentage of retainage on payments made by the owner to the prime contractor shall be subject to interest to be paid by the prime contractor to the subcontractor at the rate of one percent (1%) per month or fraction thereof.

d. Nothing in this section shall prevent the prime contractor at the time of application and certification to the owner from withholding application and certification to the owner for payment to the subcontractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of subcontractor to make timely payments for labor, equipment and materials; damage to prime contractor or another subcontractor; reasonable evidence that subcontract cannot be completed for the unpaid balance of the subcontract sum; or a reasonable amount for retainage not to exceed the initial percentage retained by owner.

ARTICLE 18 - DESIGNER'S STATUS

a. The designer shall provide general administration of the performance of construction contracts, including liaison and necessary inspection of the work to ensure compliance with plans and specifications. He is the agent of the owner only for the purpose of constructing this work and to the extent stipulated in the contract documents. He has authority to direct work to be performed, to stop work, to order work removed, or to order corrections of faulty work, where any such action by the designer may be necessary to assure successful completion of the work.

b. The designer is the impartial interpreter of the contract documents, and, as such, he shall exercise his powers under the contract to enforce faithful performance by both the owner and the contractor, taking sides with neither.

c. Should the designer cease to be employed on the work for any reason whatsoever, then the owner shall employ a competent replacement who shall assume the status of the former designer.

d. The designer and his consultants will make inspections of the project. He will inspect the progress, the quality and the quantity of the work.

e. The designer and the owner shall have access to the work whenever it is in preparation and progress during normal working hours. The contractor shall provide facilities for such access so the designer and owner may perform their functions under the contract documents.

f. Based on the designer's inspections and evaluations of the project, the designer shall issue interpretations, directives and decisions as may be necessary to administer the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract.

ARTICLE 19 - CHANGES IN THE WORK

a. The owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the contractor from any guarantee given by him pertinent to the contract provisions. These changes will not affect the validity of the guarantee bond and will not relieve the surety or sureties of said bond. All extra work shall be executed under conditions of the original contract.

b. Except in an emergency endangering life or property, no change shall be made by the contractor except upon receipt of approved change order or written field order from the designer, countersigned by the owner and the state construction office authorizing such change. No claim for adjustments of the contract price shall be valid unless this procedure is followed.

A field order, transmitted by fax, electronically, or hand delivered, may be used where the change involved impacts the critical path of the work. A formal change order shall be issued as expeditiously as possible.

In the event of emergency endangering life or property, the contractor may be directed to proceed on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the designer or owner, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work the change order will be prepared as outlined under either Method "c(1)" or Method "c(2)" or both.

c. In determining the values of changes, either additive or deductive, contractors are restricted to the use of the following methods:

1. Where the extra work involved is covered by unit prices quoted in the proposal, or subsequently agreed to by the Contractor, Designer, Owner and State Construction Office the value of the change shall be computed by application of unit prices based on quantities, estimated or actual as agreed of the items involved, except is such cases where a quantity exceeds the estimated quantity allowance in the contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c2 herein. If neither party elects to proceed under c2, then unit prices shall apply.

2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the contract price.

d. Under Paragraph “b” and Methods "c(2)" above, the allowances for overhead and profit combined shall be as follows: all contractors (the single contracting entity (prime), his subcontractors(1st tier subs), or their sub-subcontractors (2nd tier subs, 3rd tier subs, etc)) shall be allowed a maximum of 10% on work they each self-perform; the prime contractor shall be allowed a maximum of 5% on contracted work of his 1st tier sub; 1st tier, 2nd tier, 3rd tier, etc contractors shall be allowed a maximum of 2.5% on the contracted workof their subs. ; Under Method "c(1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c(2)" and Paragraph (b) above, the contractor shall include no less than five percent (5%***)*** profit, but no allowances for overhead.

e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:

1. The actual costs of materials and supplies incorporated or consumed as part of the work;

2. The actual costs of labor expended on the project site; labor expended in coordination, change order negotiation, record document maintenance, shop drawing revision or other tasks necessary to the administration of the project are considered overhead whether they take place in an office or on the project site.

3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker’s compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;

4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the work;

5. The actual costs of premiums for bonds, insurance, permit fees, and sales or use taxes related to the work.

Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the owner.

f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods. All change orders shall be supported by a unit cost breakdown showing method of arriving at net cost as defined above.

g. In all change orders, the procedure will be for the designer to request proposals for the change order work in writing. The contractor will provide such proposal and supporting data in suitable format. The designer shall verify correctness. Delay in the processing of the change order due to lack of proper submittal by the contractor of all required supporting data shall not constitute grounds for a time extension or basis of a claim. Within fourteen (14) days after receipt of the contractor’s accepted proposal including all supporting documentation required by the designer**,** the designer shall prepare the change order and forward to the contractor for his signature or otherwise respond, in writing, to

the contractor's proposal. Within seven (7) days after receipt of the change order executed by the contractor, the designer shall, certify the change order by his signature, and forward the change order and all supporting data to the owner for the owner's signature. The owner shall execute the change order and forward to the State Construction Office for final approval**,** within seven (7) days of receipt. The State Construction Office shall act on the change order within seven (7) days. In case of emergency or extenuating circumstances, approval of changes may be obtained verbally by telephone or field orders approved by all parties, then shall be substantiated in writing as outlined under normal procedure.

h. At the time of signing a change order, the contractor shall be required to certify as follows:

"I certify that my bonding company will be notified forthwith that my contract has been changed by the amount of this change order, and that a copy of the approved change order will be mailed upon receipt by me to my surety."

i. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.

j. If, during the progress of the work, the owner requests a change order and the contractor's terms are unacceptable, the owner**,** with the approval of the State Construction Office, may require the contractor to perform such work on a time and material basis whereupon the contractor shall proceed and keep accurately on such form as specified by the Designer or owner, a correct account of cost together with all proper invoices, payrolls and supporting data. Upon completion of the work a change order will be prepared with allowances for overhead and profit per paragraph d. above and "net cost" and "cost" per paragraph e. above. Without prejudice, nothing in this paragraph shall preclude the owner from performing or to have performed that portion of the work requested in the change order.

ARTICLE 20 - CLAIMS FOR EXTRA COST

a. Should the contractor consider that as a result of instructions given by the designer, he is entitled to extra cost above that stated in the contract, he shall give written notice thereof to the designer within seven (7) days without delay. The written notice shall clearly state that a claim for extra cost is being made and shall provide a detailed justification for the extra cost. The contractor shall not proceed with the work affected until further advised, except in emergency involving the safety of life or property, which condition is covered in Article 19(b) and Article 11(h). No claims for extra compensation shall be considered unless the claim is so made. The designer shall render a written decision within seven (7) days of receipt of claim.

b. The contractor shall not act on instructions received by him from persons other than the designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The designer shall not be responsible for misunderstandings claimed by the contractor of verbal instructions which have not been confirmed in writing, and in no case shall instructions be interpreted as permitting a departure from the contract documents unless such instruction is confirmed in writing and supported by a properly authorized change order.

c. Should a claim for extra compensation that complies with the requirements of (a) above by the contractor and is denied by the designer or owner, and cannot be resolved by a

representative of the State Construction Office, the contractor may request a mediation in connection with GS 143-128(f1) in the dispute resolution rules adopted by the State Building Commission (1 N.C.A.C. 30H .0101 through .1001). If the contractor is unable to resolve its claim as a result of mediation, the contractor may pursue the claim in accordance with the provisions of G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner,and the following:

1. A contractor who has not completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The director may deny, allow or compromise the claim, in whole or in part. A claim under this subsection is not a contested case under Chapter 150B of the General Statutes.

2. (a) A contractor who has completed a contract with a board for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the director of the State Construction Office of the Department of Administration for the amount the contractor claims is due. The claim shall be submitted within sixty (60) days after the contractor receives a final statement of the board's disposition of his claim and shall state the factual basis for the claim.

   (b) The director shall investigate a submitted claim within ninety (90) days of receiving the claim, or within any longer time period upon which the director and the contractor agree. The contractor may appear before the director, either in person or through counsel, to present facts and arguments in support of his claim. The director may allow, deny or compromise the claim, in whole or in part. The director shall give the contractor a written statement of the director's decision on the contractor's claim.

   (c) A contractor who is dissatisfied with the director's decision on a claim submitted under this subsection may commence a contested case on the claim under Chapter 150B of the General Statutes. The contested case shall be commenced within sixty (60) days of receiving the director's written statement of the decision.

   (d) As to any portion of a claim that is denied by the director, the contractor may, in lieu of the procedures set forth in the preceding subsection of this section, within six (6) months of receipt of the director's final decision, institute a civil action for the sum he claims to be entitled to under the contract by filing a verified complaint and the issuance of a summons in the Superior Court of Wake County or in the superior court of any county where the work under the contract was performed. The procedure shall be the same as in all civil actions except that all issues shall be tried by the judge, without a jury.

ARTICLE 21 - MINOR CHANGES IN THE WORK

The designer will have the authority to order minor changes in the work not involving an adjustment in the contract sum or time for completion, and not inconsistent with the intent of the contract documents. Such changes shall be effected by written order, copied to the State Construction Office, and shall be binding on the owner and the contractor.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the owner and the designer, the owner shall be reimbursed by the contractor. A change order will be issued to reflect a reduction in the contract sum.

ARTICLE 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME

a. The time of completion is stated in the Supplementary General Conditions and in the Form of Construction Contract. The Project Expediter, upon notice of award of contract, shall prepare a construction schedule to complete the project within the time of completion as required by Article 14.

b. The contractors shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the designer and shall fully complete all work hereunder within the time of completion stated. Time is of the essence and the contractor acknowledges the Owner will likely suffer financial damage for failure to complete the work within the time of completion. For each day in excess of the above number of days, the contractor(s) shall pay the owner the sum stated as liquidated damages reasonably estimated in advance to cover the losses to be incurred by the owner by reason of failure of said contractor(s) to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof.

c. In the event of multiple prime contractors, the designer shall be the judge as to the division of responsibility between the contractor(s), based on the construction schedule, weekly reports and job records, and shall apportion the amount of liquidated damages to be paid by each of them, according to delay caused by any or all of them.

d. If the contractor is delayed at any time in the progress of his work solely by any act or negligence of the owner, the designer, or by any employee of either; by any separate contractor employed by the owner; by changes ordered in the work; by labor disputes at the project site; by abnormal weather conditions not reasonably anticipated for the locality where the work is performed; by unavoidable casualties; by any causes beyond the contractor's control; or by any other causes which the designer and owner determine may justify the delay, then the contract time may be extended by change order only for the time which the designer and owner may determine is reasonable.

   Time extensions will not be granted for rain, wind, snow or other natural phenomena of normal intensity for the locality where work is performed. For purpose of determining extent of delay attributable to unusual weather phenomena, a determination shall be made by comparing the weather for the contract period involved with the average of the preceding five (5) year climatic range during the same time interval based on the National Oceanic and Atmospheric Administration National Weather Service statistics for the locality where work is performed and on daily weather logs kept on the job site by the contractor reflecting the effect of the weather on progress of the work and initialed by the designer's representative. No weather delays shall be considered after the building is dried in unless work claimed to be delayed is on the critical path of the baseline schedule or approved updated schedule. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents. Contractor caused delays shall be accounted for before owner or designer caused delays in the case of concurrent delays.

e. Request for extension of time shall be made in writing to the designer, copies to the owner and SCO, within twenty (20) days following cause of delay. In case of continuing cause for delay, the Contractor shall notify the_Designer to the designer, copies to the owner and SCO, of the delay within 20 days of the beginning of the delay and only one claim is necessary.

f. The contractor shall notify his surety in writing of extension of time granted.

g. No claim for time extension shall be allowed on account of failure of the designer to furnish drawings or instructions until twenty (20) days after demand for such drawings and/or instructions. See Article 5c. Demand must be in written form clearly stating the potential for delay unless the drawings or instructions are provided. Any delay granted will begin after the twenty (20) day demand period is concluded.

ARTICLE 24 - PARTIAL UTILIZATION/BENEFICIAL OCCUPANCY

a. The owner may desire to occupy or utilize all or a portion of the project prior to the completion of the project.

b. Should the owner request a utilization of a building or portion thereof, the designer shall perform a designer final inspection of area after being notified by the contractor that the area is ready for such. After the contractor has completed designer final inspection punch list and the designer has verified, then the designer shall schedule a beneficial occupancy inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office. If beneficial occupancy is granted by the State Construction Office, in such areas the following will be established:

1. The beginning of guarantees and warranties period for the equipment necessary to support. in the area.

2. The owner assumes all responsibiliites for utility costs for entire building.

2. Contractor will obtain consent of surety.

3. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.

c. The owner shall have the right to exclude the contractor from any part of the project which the designer has so certified to be substantially complete, but the owner will allow the contractor reasonable access to complete or correct work to bring it into compliance with the contract.

d. Occupancy by the owner under this article will in no way relieve the contractor from his contractual requirement to complete the project within the specified time. The contractor will not be relieved of liquidated damages because of beneficial occupancy. The designer may prorate liquidated damages based on the percentage of project occupied.

ARTICLE 25 - FINAL INSPECTION, ACCEPTANCE, AND PROJECT CLOSEOUT

a. Upon notification from the contractor(s) that the project is complete and ready for inspection, the designer shall make a Designer final inspection to verify that the project is complete and ready for SCO final inspection. Prior to SCO final inspection, the contractor(s) shall complete all items requiring corrective measures noted at the Designer

final inspection**.** The designer shall schedule a SCO final inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office.

b. At the SCO final inspection, the designer and his consultants shall, if job conditions warrant, record a list of items that are found to be incomplete or not in accordance with the contract documents. At the conclusion of the SCO final inspection, the designer and State Construction Office representative shall make one of the following determinations:

   1. That the project is completed and accepted.

   2. That the project will be accepted subject to the correction of the list of discrepancies (punch list). All punch list items must be completed within thirty (30) days of SCO final inspection or the owner may invoke Article 28, Owner's Right to Do Work.

   4. That the project is not complete and another date for a SCO final inspection will be established.

c. Within fourteen (14) days of final acceptance per Paragraph b1 or within fourteen (14) days after completion of punch list per Paragraph b2 above, the designer shall certify the work and issue applicable certificate(s) of compliance.

d. Any discrepancies listed or discovered after the date of SCO final inspection and acceptance under Paragraphs b1 or b2 above shall be handled in accordance with Article 42, Guarantee.

f. The final acceptance date will establish the following:

   1. The beginning of guarantees and warranties period.

   2. The date on which the contractor's insurance coverage for public liability, property damage and builder's risk may be terminated.

   3. That no liquidated damages (if applicable) shall be assessed after this date.

   4. The termination date of utility cost to the contractor.

g. Prior to issuance of final acceptance date, the contractor shall have his authorized representatives visit the project and give full instructions to the designated personnel regarding operating, maintenance, care, and adjustment of all equipment and special construction elements. In addition, the contractor shall provide to the owner a complete instructional video (media format acceptable to the owner) on the operation, maintenance, care and adjustment of all equipment and special construction elements.

ARTICLE 26 - CORRECTION OF WORK BEFORE FINAL PAYMENT

a. Any work, materials, fabricated items or other parts of the work which have been condemned or declared not in accordance with the contract by the designer shall be promptly removed from the work site by the contractor, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the owner. Work or property of other contractors or the owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the contractor whose work is faulty.

b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the designer, and shall make satisfactory progress, as determined by the designer, until completed.

c. Should the contractor fail to proceed with the required corrections, then the owner may complete the work in accordance with the provisions of Article 28.

ARTICLE 27 - CORRECTION OF WORK AFTER FINAL PAYMENT

See Article 35, Performance Bond and Payment Bond, and Article 42, Guarantee**.** Neither the final certificate, final payment, occupancy of the premises by the owner, nor any provision of the contract, nor any other act or instrument of the owner, nor the designer, shall relieve the contractor from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. Contractor shall correct or make good any defects due thereto and repair any damage resulting there from, which may appear during the guarantee period following final acceptance of the work except as stated otherwise under Article 42, Guarantee. The owner will report any defects as they may appear to the contractor and establish a time limit for completion of corrections by the contractor. The owner will be the judge as to the responsibility for correction of defects.

ARTICLE 28 - OWNER'S RIGHT TO DO WORK

If, during the progress of the work or during the period of guarantee, the contractor fails to prosecute the work properly or to perform any provision of the contract, the owner, after seven (7) days' written notice sent by certified mail, return receipt requested, to the contractor from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the contractor, such action and cost of same having been first approved by the designer. Should the cost of such action of the owner exceed the amount due or to become due the contractor, then the contractor or his surety, or both, shall be liable for and shall pay to the owner the amount of said excess.

ARTICLE 29 - ANNULMENT OF CONTRACT

If the contractor fails to begin the work under the contract within the time specified, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the owner may give notice in writing, sent by certified mail, return receipt requested, to the contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor within a period of seven (7) days after such notice shall not proceed in accordance therewith, then the owner shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within seven (7) days after being so notified and notify the owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said contractor, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof

or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the owner, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due said contractor and surety. In case the expense so incurred by the owner shall be less than the sum which would have been payable under the contract, if it had been completed by said contractor, then the said contractor and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and the surety shall be liable and shall pay to the owner the amount of said excess.

ARTICLE 30 - CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE THE CONTRACT

a. Should the work be stopped by order of a court having jurisdiction, or by order of any other public authority for a period of three months, due to cause beyond the fault or control of the contractor, or if the owner should fail or refuse to make payment on account of a certificate issued by the designer within forty-five (45) days after receipt of same, then the contractor, after fifteen (15) days' written notice sent by certified mail, return receipt requested, to the owner and the designer, may suspend operations on the work or terminate the contract.

b. The owner shall be liable to the contractor for the cost of all materials delivered and work performed on this contract plus 10 percent overhead and profit and shall make such payment. The designer shall be the judge as to the correctness of such payment.

ARTICLE 31 - REQUEST FOR PAYMENT

a. Not later than the fifth day of the month, the contractor shall submit to the designer a request for payment for work done during the previous month. The request shall be in the form agreed upon between the contractor and the designer, but shall show substantially the value of work done and materials delivered to the site during the period since the last payment, and shall sum up the financial status of the contract with the following information:

    1. Total of contract including change orders.

    2. Value of work completed to date.

    3. Less five percent (5%) retainage, provided however, that after fifty percent (50%) of the contractor’s work has been satisfactorily completed on schedule, with approval of the owner and the State Construction Office and written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule.

    4. Less previous payments.

    5. Current amount due.

b. The contractor, upon request of the designer, shall substantiate the request with invoices of vouchers or payrolls or other evidence.

c. Prior to submitting the first request, the contractor shall prepare for the designer a schedule showing a breakdown of the contract price into values of the various parts of the work, so arranged as to facilitate payments to subcontractors in accordance with Article 17, Contractor and Subcontractor Relationships. The contractor(s) shall list the

value of each subcontractor and supplier, identifying each minority business subcontractor and supplier as listed in Affidavit C, if applicable.

d. When payment is made on account of stored materials and equipment, such materials must be stored on the owner's property, and the requests for payments shall be accompanied by invoices or bills of sale or other evidence to establish the owner's title to such materials and equipment. Such payments will be made only for materials that have been customized or fabricated specifically for this project. Raw materials or commodity products including but not limited to piping, conduit, CMU, metal studs and gypsum board may not be submitted. Responsibility for such stored materials and equipment shall remain with the contractor regardless of ownership title. Such stored materials and equipment shall not be removed from the owner's property. Should the space for storage on-site be limited, the contractor, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the contractor desire to include any such materials or equipment in his application for payment, they must be stored in the name of the owner in an independent, licensed, bonded warehouse approved by the designer, owner and the State Construction Office and located as close to the site as possible. The warehouse selected must be approved by the contractor's bonding and insurance companies; the material to be paid for shall be assigned to the owner and shall be inspected by the designer. Upon approval by the designer, owner and SCO of the storage facilities and materials and equipment, payment therefore will be certified. Responsibility for such stored materials and equipment shall remain with the contractor. Such stored materials and equipment shall not be moved except for transportation to the project site. Under certain conditions, the designer may approve storage of materials at the point of manufacture, which conditions shall be approved by the designer, the owner and the State Construction Office prior to approval for the storage and shall include an agreement by the storing party which unconditionally gives the State absolute right to possession of the materials at anytime. Bond, security and insurance protection shall continue to be the responsibility of the contractor(s).

e. In the event of beneficial occupancy, retainage of funds due the contractor(s) may be reduced with the approval of the State Construction Office to an equitable amount to cover the list of items to be completed or corrected. Retainage may not be reduced to less than two and one-half (2 1/2) times the estimated value of the work to be completed or corrected. Reduction of retainage must be with the consent and approval of the contractor's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

a. Within five (5) days from receipt of request for payment from the contractor, the designer shall issue and forward to the owner a certificate for payment. This certificate shall indicate the amount requested or as approved by the designer. If the certificate is not approved by the designer, he shall state in writing to the contractor and the owner his reasons for withholding payment.

b. No certificate issued or payment made shall constitute an acceptance of the work or any part thereof. The making and acceptance of final payment shall constitute a waiver of all claims by the owner except:

   1. Claims arising from unsettled liens or claims against the contractor.

   2. Faulty work or materials appearing after final payment.

   3. Failure of the contractor to perform the work in accordance with drawings and specifications, such failure appearing after payment.

4. As conditioned in the performance bond and payment bond.

c. The making and acceptance of final payment shall constitute a waiver of all claims by the contractor except those claims previously made and remaining unsettled (Article 20(c)).

d. Prior to submitting request for final payment to the designer for approval, the contractor shall fully comply with all requirements specified in the" project closeout" section of the specifications. These requirements include but not limited to the following:

1. Submittal of Product and Operating Manuals, Warranties and Bonds, Guarantees, Maintenance Agreements, As-Built Drawings, Certificates of Inspection or Approval from agencies having jurisdiction. (The designer must approve the Manuals prior to delivery to the owner).

2. Transfer of Required attic stock material and all keys in an organized manner.

3. Record of Owner's training.

4. Resolution of any final inspection discrepancies.

5. Granting access to Contractor's records, if Owner's internal auditors have made a request for such access pursuant to Article 52.

e. The contractor shall forward to the designer, the final application for payment along with the following documents:

1. List of minority business subcontractors and material suppliers showing breakdown of contract amounts and total actual payments to subs and material suppliers.

2. Affidavit of Release of Liens.

3. Affidavit of contractors of payment to material suppliers and subcontractors. (See Article 36).

4. Consent of Surety to Final Payment**.**

5. Certificates of state agencies required by state law.

f. The designer will not authorize final payment until the work under contract has been certified by designer, certificates of compliance issued, and the contractor has complied with the closeout requirements. The designer shall forward the contractor's final application for payment to the owner along with respective certificate(s) of compliance required by law.

ARTICLE 33 - PAYMENTS WITHHELD

a. The designer with the approval of the State Construction Office may withhold payment for the following reasons:

1. Faulty work not corrected.

2. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.

3. To provide for sufficient contract balance to cover liquidated damages that will be assessed.

b. The secretary of the Department of Administration may authorize the withholding of payment for the following reasons:

1. Claims filed against the contractor or evidence that a claim will be filed.

2. Evidence that subcontractors have not been paid.

c. The Owner may withhold all or a portion of Contractor's general conditions costs set forth in the approved schedule of values, if Contractor has failed to comply with: (1) a request to access its records by Owner's internal auditors pursuant to Article 52; (2) a request for a plan of action and/or recovery schedule under Article 14.j or provide The Owner; (3) a request to provide an electronic copies of Contractor's baseline schedule, updates with all logic used to create the schedules in the original format of the scheduling software; and (4) Contractor's failure to have its Superintendent on the Project full-time; (

d. When grounds for withholding payments have been removed, payment will be released. Delay of payment due the contractor without cause will make owner liable for payment of interest to the contractor in accordance with G.S. 143-134.1. As provided in G.S.143-134.1(e) the owner shall not be liable for interest on payments withheld by the owner for unsatisfactory job progess, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

ARTICLE 34 - MINIMUM INSURANCE REQUIREMENTS

The work under this contract shall not commence until the contractor has obtained all required insurance and verifying certificates of insurance have been approved in writing by the owner. These certificates shall document that coverages afforded under the policies will not be cancelled, reduced in amount or coverages eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the owner of such alteration or cancellation. If endorsements are needed to comply with the notification or other requirements of this article copies of the endorsements shall be submitted with the certificates.

a. **Worker's Compensation and Employer's Liability**

The contractor shall provide and maintain, until final acceptance, workmen's compensation insurance, as required by law, as well as employer's liability coverage with minimum limits of $100,000.

b. **Public Liability and Property Damage**

The contractor shall provide and maintain, until final acceptance, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the contractor or by any subcontractor, or by

anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury:	$500,000 per occurrence
Property Damage:	$100,000 per occurrence / $300,000 aggregate

In lieu of limits listed above, a $500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

c. **Property Insurance (Builder's Risk/Installation Floater)**

The contractor shall purchase and maintain property insurance until final acceptance, upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the owner, the contractor, the subcontractors and sub-subcontractors in the work and shall insure against the perils of fire, wind, rain, flood, extended coverage, and vandalism and malicious mischief. If the owner is damaged by failure of the contractor to purchase or maintain such insurance, then the contractor shall bear all reasonable costs properly attributable thereto; the contractor shall effect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

d. **Deductible**

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the contractor.

e. **Other Insurance**

The contractor shall obtain such additional insurance as may be required by the owner or by the General Statutes of North Carolina including motor vehicle insurance, in amounts not less than the statutory limits.

f. **Proof of Carriage**

The contractor shall furnish the owner with satisfactory proof of carriage of the insurance required before written approval is granted by the owner.

ARTICLE 35 - PERFORMANCE BOND AND PAYMENT BOND

a. Each contractor shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount. Bonds shall be executed in the form bound with these specifications.

b. All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

ARTICLE 36 - CONTRACTOR'S AFFIDAVIT

The final payment of retained amount due the contractor on account of the contract shall not become due until the contractor has furnished to the owner through the designer an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work in connection with his contract have been satisfied, and that no claims or

liens exist against the contractor in connection with this contract. In the event that the contractor cannot obtain similar affidavits from subcontractors to protect the contractor and the owner from possible liens or claims against the subcontractor, the contractor shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the contractor's) knowledge, and if any appear afterward, the contractor shall save the owner harmless.

ARTICLE 37 - ASSIGNMENTS

The contractor shall not assign any portion of this contract nor subcontract in its entirety. Except as may be required under terms of the performance bond or payment bond, no funds or sums of money due or become due the contractor under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

a. The contractor(s) shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the designer and owner and shall not exceed those established limits in his operations.

b. The contractor(s) shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.

c. The contractor(s) shall enforce the designer's and owner’s instructions regarding signs, advertisements, fires and smoking.

d. No firearms, any type of alcoholic beverages, or drugs (other than those prescribed by a physician) will be permitted at the job site.

ARTICLE 39 - CUTTING, PATCHING AND DIGGING

a. The contractor shall do all cutting, fitting or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors shown upon or reasonably implied by the drawings and specifications for the completed structure, as the designer may direct.

b. Any cost brought about by defective or ill-timed work shall be borne by the party responsible therefor.

c. No contractor shall endanger any work of another contractor by cutting, digging or other means. No contractor shall cut or alter the work of any other contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

a. The contractor shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer and other utility services which maybe necessary and required for completion of the project including all utilities required for testing, cleaning, balancing, and sterilization of designated plumbing, mechanical and electrical systems. Any permanent meters installed shall be listed in the contractor’s name until work has a final acceptance. The contractor will be solely responsible for all utility costs prior to final acceptance. Contractor shall contact all affected utility companies prior to bid to determine their requirements to provide temporary and permanent service and include all costs associated with providing those services in their bid. Coordination of the work of the utility companies during construction is the sole responsibility of the contractor.

b. Meters shall be relisted in the owner's name on the day following final acceptance of the Project Expediter's work, and the owner shall pay for services used after that date.

c. The owner shall be reimbursed for all metered utility charges after the meter is relisted in the owner's name and prior to completion and acceptance of the work of **all** contractors. Reimbursement shall be made by the contractor whose work has not been completed and accepted. If the work of two or more contractors has not been completed and accepted, reimbursement to the owner shall be paid by the contractors involved on the basis of assessments by the designer.

d Prior to the operation of permanent systems, the Project Expediter will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.

e. All contractors shall have the permanent building systems in sufficient readiness for furnishing temporary climatic control at the time a building is enclosed and secured. The HVAC systems shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishes of the building. A building shall be considered enclosed and secured when windows**,** doorways (exterior, mechanical, and electrical equipment rooms), and hardware are installed**;** and other openings have protection which will provide reasonable climatic control. The appropriate time to start the mechanical systems and climatic condition shall be jointly determined by the contractor(s), the designer and owner. Use of the equipment in this manner shall be subject to the approval of the Designer and owner and shall in no way affect the warranty requirements of the contractor(s).

f. The electrical contractor shall have the building's permanent power wiring distribution system in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.

g. The electrical contractor shall have the building's permanent lighting system ready at the time the general contractor begins interior painting and shall provide adequate lighting in those areas where interior painting and finishing is being performed.

h. Each prime contractor shall be responsible for his permanently fixed service facilities and systems in use during progress of the work. The following procedures shall be strictly adhered to:

1. Prior to final acceptance of work by the State Construction Office, each contractor shall remove and replace any parts of the permanent building systems damaged through use during construction.

2. Temporary filters as recommended by the equipment manufacturer in order to keep the equipment and ductwork clean and free of dust and debris shall be installed in each of the heating and air conditioning units and at each return grille during construction. New filters shall be installed in each unit prior to the owner's acceptance of the work.

3. Extra effort shall be maintained to keep the building and the site adjacent to the building clean and under no circumstances shall air systems be operated if finishing and site work operations are creating dust in excess of what would be considered normal if the building were occupied.

4. It shall be understood that any warranty on equipment presented to the owner shall extend from the day of final acceptance by the owner. The cost of warranting the

equipment during operation in the finishing stages of construction shall be borne by the contractor whose system is utilized.

5. The electrical contractor shall have all lamps in proper working condition at the time of final project acceptance.

i. The Project Expediter shall provide, if required and where directed, a shed for toilet facilities and shall furnish and install in this shed all water closets required for a complete and adequate sanitary arrangement. These facilities will be available to other contractors on the job and shall be kept in a neat and sanitary condition at all times. Chemical toilets are acceptable.

j. The Project Expediter shall, if required by the Supplementary General Conditions and where directed, erect a temporary field office, complete with lights, telephone, heat and air conditioning. A portion of this office shall be partitioned off, of sufficient size, for the use of a resident inspector, should the designer so direct.

k. On multi-story construction projects, the Project Expediter shall provide temporary elevators, lifts, or other special equipment for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall be included in the Project Expediter's bid.

l. The Project Expediter will erect one sign on the project if required. The sign shall be of sound construction, and shall be neatly lettered with black letters on white background. The sign shall bear the name of the project, and the names of prime contractors on the project, and the name of the designer and consultants. Directional signs may be erected on the owner's property subject to approval of the owner with respect to size, style and location of such directional signs. Such signs may bear the name of the contractor and a directional symbol. No other signs will be permitted except by permission of the owner.

ARTICLE 41 - CLEANING UP

a. The contractors shall keep the building and surrounding area reasonably free from rubbish at all times, and shall remove debris from the site on a timely basis or when directed to do so by the designer or Project Expediter. The Project Expediter shall provide an on site refuse container(s) for the use of all contractors. Each contractor shall remove their rubbish and debris from the building on a daily basis. The Project Expediter shall broom clean the building as required to minimize dust and dirt accumulation.

b. The Project Expediter shall provide and maintain suitable all-weather access to the building**.**

c. Before final inspection and acceptance of the building, each contractor shall clean his portion of the work, including glass, hardware, fixtures, masonry, tile and marble (using no acid), clean and wax all floors as specified, and completely prepare the building for use by the owner, with no cleaning required by the owner.

ARTICLE 42 - GUARANTEE

a. The contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the date of final acceptance of the work or beneficial occupancy and shall replace such defective materials or workmanship without cost to the owner.

b. Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The contractor shall replace such defective equipment or materials, without cost to the owner, within the manufacturer's warranty period.

c. Additionally, the owner may bring an action for latent defects caused by the negligence of the contractor which is hidden or not readily apparent to the owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

d. Guarantees for roof, equipment, materials, and supplies shall be stipulated in the specifications sections governing such roof, equipment, materials, or supplies.

ARTICLE 43 - CODES AND STANDARDS

Wherever reference is given to codes, standard specifications or other data published by regulating agencies including, but not limited to, national electrical codes, North Carolina state building codes, federal specifications, ASTM specifications, various institute specifications, etc., it shall be understood that such reference is to the latest edition including addenda published prior to the date of the contract documents.

ARTICLE 44 - INDEMNIFICATION

To the fullest extent permitted by law, the contractor shall indemnify and hold harmless the owner, the designer and the agents, consultants and employees of the owner and designer, from and against all claims, damages, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance or failure of performance of the work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting there from, and (2) is caused in whole or in part by any negligent act or omission of the contractor, the contractor's subcontractor, or the agents of either the contractor or the contractor's subcontractor. Such obligation shall not be construed to negate, abridge or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this article.

ARTICLE 45 - TAXES

a. Federal excise taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3442(3)).

b. Federal transportation taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3475(b) as amended).

c. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.

d. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal and contract sum.

e. **Accounting Procedures for Refund of County Sales & Use Tax**

Amount of county sales and use tax paid per contractor's statements:

Contractors performing contracts for state agencies shall give the state agency for whose project the property was purchased a signed statement containing the information listed in G.S. 105-164.14(e).

The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from contractors, an agency may obtain a certified statement as of April 1, 1991 from the contractor setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and the amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The contractor should also be notified that the certified statement may be subject to audit.

In the event the contractors make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the contractor's warehouse stock and the amount of county sales or use tax paid thereon by the contractor.

Similar certified statements by his subcontractors must be obtained by the general contractor and furnished to the claimant.
Contractors are not to include any tax paid on supplies, tools and equipment which they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment which actually become a part of or annexed to the building or structure.

ARTICLE 46 - EQUAL OPPORTUNITY CLAUSE

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the secretary of Labor, are incorporated herein.

ARTICLE 47 - EMPLOYMENT OF INDIVIDUALS WITH DISABILITIES

The contractor(s) agree not to discriminate against any employee or applicant for employment because of physical or mental disabilities in regard to any position for which the employee or applicant is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified individuals with such disabilities without discrimination based upon their physical or mental disability in all employment practices.

ARTICLE 48 - ASBESTOS-CONTAINING MATERIALS (ACM)

The State of North Carolina has attempted to address all asbestos-containing materials that are to be disturbed in the project. However, there may be other asbestos-containing materials in the work areas that are not to be disturbed and do not create an exposure hazard.

Contractors are reminded of the requirements of instructions under Instructions to Bidders and General Conditions of the Contract, titled Examination of Conditions. Statute 130A, Article 19, amended August 3, 1989, established the Asbestos Hazard Management Program that controls asbestos abatement in North Carolina. The latest edition of *Guideline Criteria for Asbestos Abatement* from the State Construction Office is to be incorporated in all asbestos abatement projects for the Capital Improvement Program.

ARTICLE 49 - MINORITY BUSINESS PARTICIPATION

GS 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix E are hereby incorporated into and made a part of this contract.

ARTICLE 50 – CONTRACTOR EVALUATION

The contractor's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to bid on future State capital improvement projects. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, Contractor Evaluation Procedures, is hereby incorporated and made a part of this contract. The owner may request the contractor's comments to evaluate the designer.

ARTICLE 51 – GIFTS

Pursuant to N.C. Gen. Stat. § 133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, subcontractor, supplier, vendor, etc.), to make gifts or to give favors to any State employee. This prohibition covers those vendors and contractors who: (1) have a contract with a governmental agency; or (2) have performed under such a contract within the past year; or (3) anticipate bidding on such a contract in the future. For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review G.S. Sec. 133-32.

During the construction of the Project, the Contractor is prohibited from making gifts to any of the Owner's employees, Owner's project representatives (architect, engineers, construction manager and their employees), employees of the State Construction Office and/or any other State employee that may have any involvement, influence, responsibilities, oversight, management and/or duties that pertain to and/or relate to the contract administration, financial administration and/or disposition of claims arising from and/or relating to the Contract and/or Project.

ARTICLE 52 – AUDITING-ACCESS TO PERSONS AND RECORDS

In accordance with N.C. General Statute 147-64.7, the State Auditor shall have access to Contractor's officers, employees, agents and/or other persons in control of and/or responsible for the Contractor's records that relate to this Contracts for purposes of conducting audits under the referenced statute. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or

relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

ARTICLE 53 – NORTH CAROLINA FALSE CLAIMS ACT

The North Carolina False Claims Act ("NCFCA"), N.C Gen. Stat. § 1-605 through 1-618, applies to this Contract. The Contractor should familiarize itself with the entire NCFCA and should seek the assistance of an attorney if it has any questions regarding the NCFCA and its applicability to any requests, demands and/or claims for payment its submits to the State through the contracting state agency, institution, university or community college.

The purpose of the NCFCA "is to deter persons from knowingly causing or assisting in causing the State to pay claims that are false or fraudulent and to provide remedies in the form of treble damages and civil penalties when money is obtained from the State by reason of a false or fraudulent claim." (Section 1-605(b).) A contractor's liability under the NCFCA may arise from, but is not limited to: requests for payment, invoices, billing, claims for extra work, requests for change orders, requests for time extensions, claims for delay damages/extended general conditions costs, claims for loss productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, documentation used to support any of the foregoing requests or claims, and/or any other request for payment from the State through the contracting state agency, institution, university or community college. The parts of the NCFCA that are most likely to be enforced with respect to this type of contract are as follows:

- A "claim" is "[a]ny request or demand, whether under a contract or otherwise, for money or property and whether or not the State has title to the money or property that (i) is presented to an officer, employee, or agent of the State or (ii) is made to a contractor … if the money or property is to be spent or used on the State's behalf or to advance a State program or interest and if the State government: (a) provides or has provided any portion of the money or property that is requested or demanded; or (b) will reimburse such contractor … for any portion of the money or property which is requested or demanded." (Section 1-606(2).)

- "Knowing" and "knowingly." – Whenever a person, with respect to information, does any of the following: (a) Has actual knowledge of the information; (b) Acts in deliberate ignorance of the truth or falsity of the information; and/or (c) Acts in reckless disregard of the truth or falsity of the information. (Section 1-606(4).) Proof of specific intent to defraud is not required. (Section 1-606(4).)

- "Material" means having a natural tendency to influence, or be capable of influencing, the payment or receipt of money or property. (Section 1-606(4).)

- Liability. – "Any person who commits any of the following acts shall be liable to the State for three times the amount of damages that the State sustains because of the act of that person[:] … (1) Knowingly presents or causes to be presented a false or fraudulent claim for payment or approval. (2) Knowingly makes, uses, or causes to be made or used, a false record or statement material to a false or fraudulent claim. (3) Conspires to commit a violation of subdivision (1), (2) …" (Section 1-607(a)(1), (2).)

- The NCFCA shall be interpreted and construed so as to be consistent with the federal False Claims Act, 31 U.S.C. § 3729, et seq., and any subsequent amendments to that act. (Section 1-616(c).)

Finally, the contracting state agency, institution, university or community college may refer any suspected violation of the NCFCA by the Contractor to the Attorney General's Office for investigation. Under Section 1-608(a), the Attorney General is responsible for investigating any violation of NCFCA, and may bring a civil action against the Contractor under the NCFCA. The Attorney General's investigation and any civil action relating thereto are independent and not subject to any dispute resolution provision set forth in this Contract. (See Section 1-608(a).)

ARTICLE 54 – TERMINATION FOR CONVENIENCE

Owner may at any time and for any reason terminate Contractor's services and work at Owner's convenience. Upon receipt of such notice, Contractor shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

Upon such termination, Contractor shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by Contractor as are permitted by the prime contract and approved by Owner; (3) plus ten percent (10%) of the cost of the work referred to in subparagraph (1) above for overhead and profit. There shall be deducted from such sums as provided in this subparagraph the amount of any payments made to Contractor prior to the date of the termination of this Agreement. Contractor shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

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UNC-CH GENERAL REQUIREMENTS
OCTOBER 28, 2015

1. Owners' Representative

The UNC-CH Department of Construction Management represents the Owner in all matters pertaining to contract construction. The Department will designate a Construction Manager, who will be the single spokesperson for the University. All official contact, decisions, direction, problem resolution and coordination to/from the University will be through the assigned Construction Manager and the Designer. This does not alleviate any of the Designers' responsibilities as stated in the General Conditions.

2. Inspections and Testing

The University will arrange for independent testing agencies to make tests and conduct inspections of work in progress. The contractors will give reasonable notice of construction activities to be tested/inspected so that the testing agency may be present.

In addition to the normally-anticipated inspections, the University intends to conduct the following inspections, which contractors should allow for in their schedules: above-ceiling inspections, pre-final inspections, 100% test of fire protection systems, and final inspections. Any of these inspections which are not completed satisfactorily will be repeated at no cost to the owner and without time extension.

Above-Ceiling Inspections: The above-ceiling inspection will be conducted by the University after above-ceiling systems have been completed and verified by the Designer. The following general guidelines will apply to this inspection:

a. All above ceiling systems will be completed including, but not limited to, controls, insulation, labeling of systems, wiring, light fixtures, diffusers, ductwork, piping, fire proofing, and sealing of wall penetrations through fire walls.

b. Framing for hard ceiling will be completed and access door locations will be framed to assure accessibility to control valves, equipment requiring maintenance, etc. Ceiling grid will be in place and equipment (light fixtures, diffusers, etc.) will be in place in the grid.

c. Under no circumstances will any ceiling area be covered up until this inspection is done by the owner. The contractor shall give the Designer and the University two weeks notice to assure owner personnel is available.

Fire Protection Systems: The installation contractor must conduct a 100% performance test, which shall be ensured by the designer/engineer. When this test is completed and deficiencies corrected, the owner will conduct a 100% test of the system, which shall be scheduled through the University's Construction Manager. At least three days prior to the owner's test; the contractor will furnish the completed NFPA Record of Completion, with a printout of the installed database and a floor plan with database information and room numbers. These documents shall be updated and reissued prior to each additional test and final inspection.

3. Construction Schedule

Tentative dates for interruption of utilities services and traffic disruptions shall be incorporated into the project schedule. The schedule will show UNC and State inspections, punch list correction, cleanup, and final inspection, and shall anticipate 5-year-average weather delay

and the extra restrictions required for University operations as outlined in SGC Paragraph 4 below.

The schedule will also include the time allotted for commissioning the MEP systems. Unless otherwise stipulated in the project construction documents the schedule will indicate 100% commissioning of the MEP systems. The schedule will include all necessary activities and contractor and subcontractor resources to support commissioning, as well as, time and resources for correction of contract required punchlist items generated by the commissioning agent.

4. Working Hours

The contractor may establish a work schedule of his own choosing. The contractor shall submit to the UNC Construction Manager and to the designer his regular daily work schedule, and shall notify the Construction Manager in advance of any deviations from the schedule. The University reserves the right to limit the contractors' activities when they conflict with University operations.

For most situations, the University will require the contractor to comply with the Town of Chapel Hill Noise Ordinance.

Extra restrictions will be enforced by the University during certain periods of the year. The contractors must allow for these restrictions in their project schedule. No time extensions will be granted for these restrictions. In general, these periods are:

a. During examination periods, generally occurring in December and April for two weeks each, and June and August for four days each.

b. Graduation, generally on a Sunday in mid-May and a Sunday in mid-December

c. Approximately 15 home basketball games per year

d. Approximately 7 home football games per year

e. University Day, October 12

f. Student move-in/move-out days, generally twice a year for one week each.

Examples of the extra restrictions include, but are not limited to:

a. During examination periods the contractor will restrict noise-making activities to the hours of 8:00am - 5:00pm. If the project involves work in or near a residence hall or a building in which an examination is being conducted, the contractor will be required to restrict further those operations which are disturbing to students, to include stopping work if necessary.

b. Work will not be permitted on Graduation Day, nor the preceding day (Saturday), nor on University Day. Extra cleanup and warning signs and barricades will be provided by the contractor.

c. Work is normally permitted on the days of sporting events and concerts, but traffic is extremely heavy on those days, and contractors may have difficulty and experience delays getting to and from the job site.

d. Work is normally permitted on student move-in/move-out days, but traffic is heavier than normal, parking is restricted, and some campus roads are temporarily closed or designated one-way.

5. Underground Utilities

Each contractor who does excavation work will be responsible for locating underground utilities prior to excavation. The contractor may obtain the services of a commercial utilities locator and/or call the various utility companies who may have lines in the area. In addition, they should notify UNC Facilities Services at least 5 days prior to excavation. The contractor will be responsible for utility interruptions caused by excavation.

The General Statutes of North Carolina requires contractors to notify NOCUTS at least two days but not more than 10 days prior to excavation on a public right of way.

6. Temporary Interruptions of Utilities and Traffic Movement

Procedures for making temporary disruptions to existing utilities, and roads and pedestrian walks shall be planned well in advance of the work and the work shall be executed in a manner to provide reasonably continuous service throughout the construction period. Connections shall be made only at times approved by the University. For interruption of service in major utility systems, the Contractor must submit to the UNC Construction Manager a step-by-step sequence of operations planned to accomplish the work. Outline must show tentative dates and times of day for shut-off and restoration of services. Upon approval of the planned operations, the Construction Manager will make arrangements with appropriate University personnel for interruption of services.

Road and sidewalk cuts shall be scheduled in advance, and made only after they have been approved by the University. Contractors shall plan and coordinate their work to minimize the duration of such disruptions. Appropriate detours shall be planned, subject to the approval of the University, giving consideration to the handicapped. Warning barricades and signs shall be installed by the contractor, as well as informational signs indicating detours. Neither service disruptions nor excavations may be made until barricades and signs are in place to protect the public. If the nature of the site does not allow barricades to be in place prior to excavation, the barricade materials must be physically present on site before excavation begins, in order that they may be erected as soon as it is possible to do so.

Barricades and signs must meet OSHA, NCDOT, and University approval, and be substantial enough to deter bypassing, vandalizing or theft. In addition to meeting all applicable codes and regulations, signs must be neat and legible at all times. Hand-made signs are not acceptable.

Caution to Bidders: Bidders are cautioned that the University will probably schedule interruption of services at times other than the contractors' normal working hours and that only designated University personnel are authorized to interrupt services. Frequently, outages are scheduled to reduce disruption of classes and special events.
Contractors are reminded of the presence on campus of handicapped students, staff, and faculty: particularly mobility impaired, visually impaired, and hearing impaired. All barricades, temporary walkways, excavation, and stockpiles of materials shall be formed in such a manner as to accommodate access, adequately warn and prevent injury to this segment of the University population.

7. Temporary Utilities

The Owner shall directly pay for all temporary and final utility consumption costs throughout the life of the project's construction and use. Owner will establish any accounts necessary to directly receive bills and shall pay for any metering devices, tap fees, or similar items as necessary. Therefore, any meters shall be listed in the Owner's name upon establishment of any temporary and permanent utility at the site and the Owner shall pay for consumption costs of utilities such as water, sewer, electricity, steam, chilled water, etc.

8. Parking and Storage

Parking is extremely limited at the University of North Carolina at Chapel Hill. Contractors must confine their parking and storage to that which they can accommodate within the limits of the construction site. There will be no parking spaces provided in the vicinity of the project for construction workers. Contractors are encouraged to locate fringe parking areas and shuttle their workers to and from the job site. If a construction fence has been erected the contractor may allow his employees to park inside the fence.

Parking for large storage trailers is limited to within the construction site.

9. Cleanliness and Site Maintenance

Campus streets, parking lots, walks and grounds connecting to the project area shall be protected from deposits of mud, sand, stone, litter, or debris in any form, and this protection shall be the responsibility of the Contractors. All mud collected on vehicle wheels must be cleaned off before leaving the construction area. Should any mud or debris collect on the streets from the construction project, this shall be removed immediately before becoming a traffic hazard or being carried into the surrounding buildings.

Where equipment must cross walks, lawns, and other transitional areas used by pedestrian and vehicular traffic, the Contractor shall provide minimum 3/4" thick plywood protective sheets for equipment to roll over.

The construction site including adjacent campus areas will be kept free of trash, litter or debris at all times. Trash cans/dumpsters shall be emptied and the contents removed from campus before they overflow.

Grass and other vegetation on the construction site shall be trimmed/mowed to maintain a neat appearance. A landscape protection area shall extend to at least the drip line of any trees or shrubs that are to remain. The landscape protection fence shall be installed prior to the initial stage of grading, excavation or tree removal. No storage, access or activity of any kind will be permitted in the landscape protection areas. The Contractor shall give the Designer two (2) weeks notification in advance for the Owner to remove trees and shrubs that will be retained by the Owner for use elsewhere.

10. Request for Payment

The first sentence only of Article 31a, General Conditions, is revised to read as follows: "Not later than the last day of the month, the contractors shall submit to the Designer a request for payment for work done through the 25th day of the month. The Owner will make payment by the end of the following calendar month, as described in Articles 31 through 33, General Conditions."

The financing arrangements on some projects require that pay applications from all vendors be submitted simultaneously and only once per calendar month. Therefore, failure to follow the above schedule may result in a contractor not being paid until the next pay application period. The only way to insure timely payment is to submit complete, accurate and timely pay applications with all supporting documents.

11. Stored Materials

Add the following sentence to Article 31d, General Conditions: "No payment may be made for stored materials which are stored outside the State of North Carolina."

12. Selection of Brick or Cast Panel for Exterior Walls

The manufacturers shall present samples to the designer for his selection from which sample patterns are to be erected or shown on the job site, after consultation with the Facilities Planning Office. The Construction Management Department will notify the architect's representative where to locate these panels. The University Buildings and Grounds Committee will review these panels and make the selection. At the time the brick panels are viewed by the committee, the contractor shall also have available samples of all significant exterior materials, including but not limited to pre-cast stone or limestone, window and door frames, glass and metal panels. The Construction Management Office will notify the designer of the final selection. In the case of cast stone panels, small samples may be submitted for selection purposes.

Completed panels must cure for at least three weeks before they are reviewed by the Building and Grounds and Committee. In addition, three weeks are required to schedule this review. Therefore the panels must be completed by the contractor a minimum of six weeks before the brick selection is needed.

13. Owner's Right To Do Work

Notwithstanding the notification requirements of the General Conditions, Article 28, should the contractor fail to respond within 24 hours, or such other time as may be prescribed by the designer or by the University's assigned Construction Manager (see paragraph 1 above), to correct a deficiency which the University determines to be endangering trees or other landscaping; or to correct any other defects where time is of the essence to prevent further damage or ensure personal safety; or to correct any impediment to University operations including access by handicapped, fire department, or operational personnel; then the owner may immediately take corrective action to prevent further endangerment or damage. The cost of the work performed by the owner shall be deducted from any amount due or to become due to the contractor, as provided for in GC, Article 28. Verbal notice shall be provided to the contractor's superintendent or project manager, followed by written confirmation.

14. Commissioning

Unless otherwise stated in the contract documents the project will include 100% commissioning of the MEP systems. The Owner will provide a third party commissioning agent for the oversight of the commissioning process. See contract documents for detailed commissioning requirements. See paragraph 3 above for scheduling requirements of the contractor for the executing the commissioning work.

15. Erosion Control Inspections for General Permit NCG010000 – Land Disturbing Activities

Where an erosion permit is required for the project the contractor will keep on file a record of the required inspection reports filled out two times a week (twice because UNC is on 303(d) listed stream) or within 24 hours of a rain event or as the permit requires and provide one copy of each report to the Universities' EH&S (Geologist) representative (919-962-9752) in addition to the other agencies as the permit may require.

16. Construction Manager at Risk

The payment of the General Conditions costs to the Construction Manager at Risk will terminate 30 days after project completion and acceptance. During this 30 day period all punchlist items shall be completed and stipulated in Article 25 of the General Conditions of the contract. The time for completion and liquidating damages will be as stipulated in the Form of Construction Manager at Risk Contract and Supplementary General Conditions of the contract.

17. O&M Manuals

All required O&M manuals and attic stock shall be approved by the designer and submitted to the Owner before final inspection and acceptance of the project. Approved O&M manuals shall be available for use during the commissioning and training for the project.

18. No Smoking Policy

Contractors working for the University will be required to comply with The University's no smoking policy. A copy of the policy follows for your reference.

The University of North Carolina at Chapel Hill No Smoking Policy

I. POLICY STATEMENT

The University of North Carolina at Chapel Hill (the "University") is dedicated to maintaining a healthy work and learning environment. While the University already prohibits smoking inside its buildings and facilities, beginning January 1st, 2008, the policy will expand to prohibit smoking in State-owned vehicles and in the outdoor according to the map (see below).

Specifically, this policy is intended to eliminate the potential for exposure to secondhand smoke and the practical effect of this policy is that the campus is smoke free. The University supports employees' and students' efforts to quit smoking and offers resources for smoking cessation as indicated on both the Environmental Health & Safety website (http://www.ehs.unc.edu) and the Campus Health Services website (http://campushealth.unc.edu) .

II. APPLICABILITY

This policy applies to all University visitors, patients, students, and employees, including faculty, EPA non-faculty, staff, and student employees. It is the responsibility of every member of the University community to conduct himself/herself in compliance with this policy.

III. SIGNAGE

The University will post signs about the policy appropriately throughout campus. Additional information can be printed from the websites listed above and shared with anyone who has questions about this policy.

IV. ENFORCEMENT

Smoking must not occur within the no smoking areas designated by signage. All smoking materials must be disposed of in the appropriate receptacles.

Visitors, patients, and students who violate the no smoking policy should be reminded of the policy and asked to comply by putting out the lighted tobacco product. If a student refuses to comply with the policy, the Dean of Students' office should be contacted. That office will follow up with the student regarding the policy and available resources.

Any University employee who violates the no smoking policy should be reminded of the policy and asked to comply by putting out the lighted tobacco product. If an employee refuses to comply with the policy, the departmental representative will notify the immediate supervisor of the noncompliant employee. The immediate supervisor will follow-up with the employee to remind him/her about the policy and available resources. Continuing violations may also result in appropriate corrective action under the applicable disciplinary policy.

V. DEPARTMENTAL PROCEDURES

All University departments and work units must establish procedures that include identification of the employee(s) responsible for understanding the policy, being able to educate visitors, patients, students, and employees, and assisting in enforcement, as needed. The Office of Human Resources can assist departments in developing their procedures.

VI. EFFECTIVE DATE

This policy is effective January 1, 2008.

19. Cost of Work

All labor burden by the CM shall be charged at 40% applied to each employees total billable labor cost.

Items that are ordered from and billed to CM's main office for specific use at the project site shall be approved as valid reimbursable costs and shall be billed to line items in the CM's general conditions.

Buildier's risk deductibles in the event of a loss on the project, due to no fault of the CM, shall be a reimbursable cost of the work.

UNC-CH Supplementary General Conditions

1. **SCOPE OF WORK**

See attached Technical Specifications and Drawings for scope of work including UNC-CH General Requirements.

2. **TIME OF COMPLETION/LIQUIDATED DAMAGES**

The Contractor shall commence work to be performed under this Contract on the date to be specified in the Notice to Proceed from the Contract Administrator and shall fully complete all work hereunder within **462** consecutive calendar days from the date specified in the Notice to Proceed.

It is expected that equipment procurement will commence upon receipt of the Notice to Proceed, including submittal review. Active construction on site shall not commence until the date identified in the Notice to Proceed as "Site Available for Work."

The following are the critical dates for the project:
Anticipated Notice to Proceed: **4/23/2024**
Site Available for Work: **7/29/2024**
Construction Completion **7/29/2025**

For each day in excess of the above number of days, the Contractor(s) shall pay the Owner liquidated damages in the amount of **$500** per consecutive calendar day.

If the Contractor is delayed at any time in the progress of the Contractor's work by any act or negligence of the Owner, the Owner's employees or the Owner's separate Contractor; by changes ordered in the work; by abnormal weather conditions; by any causes beyond the Contractor's control; or by other causes deemed justifiable by Owner, then the contract time may be reasonably extended in a written order from the Owner upon written request from the Contractor within ten (10) days following the cause for delay.

3. **CONSTRUCTION SCHEDULE**

The Contractor shall start work as specified in the Notice to Proceed. The Contractor shall submit a project work schedule before beginning work. The starting date and work schedule shall be adhered to, and the work shall be performed during the Owner's normal working hours, 8:00AM to 6:00PM. Requests by the Contractor to work outside normal working hours shall be made a minimum of one (1) week in advance to the Facilities Manager on site. The Contractor's bid shall include all costs associated with workers working outside of normal business hours and/or costs associated with workers working overtime as required to meet the specified project schedule. The Owner reserves the right to request work to be performed outside normal working hours and to limit Contractor activities when they conflict with Owner operations. Any increased costs due to Owner requirements for work outside normal hours not specified in the Contract Documents will be negotiated.

4. **UTILITIES**

The Owner will provide water and electricity to the extent they are available at the project site. The Contractor shall provide restroom facilities. The Contractor's personnel shall not use toilet or washroom facilities in the existing building.

The Contractor shall be responsible for procedures for making temporary disruptions to existing utilities serving the building, and roads and pedestrian walks shall be planned well in advance of the work and the work shall be executed in a manner to provide reasonably continuous service throughout the construction period. Interruptions of service shall be coordinated with the Contract Administrator at least seven (7) days in advance.

5. **SECURITY**

Contractor shall coordinate security requirements with the UNC-CH Construction Manager.

6. **USE OF SITE**

Work under this contract shall be performed in such a manner as to avoid interruption or interference with the operation of any existing activity on the premises or at the location of the work. The Owner may enforce extra restrictions during certain periods of the year. During examination periods, the Contactor shall restrict noise-making activities. If the project involves work in or near a building in which an exam is being conducted, the Contractor shall be required to restrict operations which are disturbing to students during the hours of the exam(s). Work will not be permitted on Graduation Day, or the day preceding it (Saturday), or on University Day (October 12).

While on campus, Contractor's and Sub-Contractor's personnel shall be identifiable at all times, for example, by wearing company names or logos on garments or hard hats.

Damage done to the University premises that are under the control of the Contractor, or damage caused by the contractor to premises used by the contractor, shall be corrected at the Contractor's expense.

The contractor shall schedule deliveries between 8:00 am and 4:00 pm. The contractor shall notify UNC's Facilities Manager of any deliveries of equipment, material or road work that will impede the flow of vehicular or pedestrian traffic. The contractor shall provide traffic control by certified traffic control personnel (vehicular and pedestrian) during these deliveries. Staging for multiple concrete / steel / other large material deliveries, crane and other large pieces of equipment must be coordinated with UNC's Facilities Manager. Walks, streets, and drives are most congested with pedestrians at the top of the hour, when making deliveries the carrier should be made aware of this and plan his deliveries accordingly.

A minimum five working days' notice must be given to UNC's Facilities Manager to block parking spaces, drives, roads, streets and pedestrian walks.

Roads, streets, drives, fire lanes must remain open at all times. Adequate clearance must be maintained for emergency vehicles to negotiate the drive. Maintain a minimum of 20 feet for fire lanes. Construction vehicles are not allowed to block, park, or stage in a fire lane. Vehicles blocking fire lanes will be ticketed and towed at the Contractor's expense.

Construction fences should be covered with fabric screening unless it blocks the view of oncoming traffic. Construction gates will swing into the construction area. The construction fences should not obstruct pedestrian or vehicle traffic unless alternate ways were designed in the site drawings and approved by UNC's Facilities Manager.

The Contractor will provide additional cleanup and warning signs and barricades if deemed necessary by the Owner.

The Contractor's scheduling and staging requirements must be coordinated with, and approved by, the UNC-CH Construction Manager.

The work shall be performed during the Owner's normal working hours, 8:00 a.m. – 8:00 p.m., Monday – Friday. Requests by the Contractor to work outside normal working hours shall be made in advance to the UNC-CH Construction Manager. The Contractor's bid shall include all costs associated with workers working outside of normal business hours and/or costs associated with workers working overtime as required to meet specified project schedule. The Owner reserves the

right to request work to be performed outside normal working hours and to limit contractor activities when they conflict with Owner operations. Any increased costs due to Owner requirements for work outside normal hours not specified in the Contract Documents will be negotiated.

Contractors working for the University are required to comply with The University of North Carolina at Chapel Hill "No Smoking Policy", which is provided herein and hereby incorporated and made a part of this contract.

7. **ALTERNATES**

See Section 012300, "Alternates" for a listing.

8. **SUBCONTRACTING**

All subcontractors shall be identified in writing and approved by the Owner prior to the start of work.

9. **SEDIMENTATION POLLUTION CONTROL ACT OF 1973**

Any land-disturbing activity performed by the Contractor in connection with the project shall comply with all erosion control measures set forth in the Contract Documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).

Upon receipt of notice that a land-disturbing activity is in violation of said Act, the Contractor shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said Act are promptly taken.

The Contractor shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this section.

To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, the Contract Administrator and the agents, consultants and employees of the Owner and Contract Administrator, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this section.

10. **SUBMITTAL DATA**

The submittal requirements are described in Section 5 of the General Conditions. Items for which submittals are required are listed below:

Pre-Submittals:

- Items referenced in Technical Specifications

Post-Submittals:

- All previously submitted documents revised to show as-built condition.
- O&M Manuals for any equipment requiring a submittal.

Data on the following items shall be sent to the Project Manager for review and approval. The submittal process is described in Section 5 of the General Terms and Conditions. Refer to “Technical Specifications” for required submittals. All Pre-Submittals shall be delivered to the Project Manager no later than the Preconstruction Meeting. The Project Manager shall receive all Post-Submittals within 30 (30) days of work completion. The final pay request shall be included with Post-Submittals.

11. **DEFINITIONS**

As defined in Article 1 of the General Conditions, the Supplementary General Conditions as well as the UNC-CH General Requirements are considered part of the contract documents.

The Owner is the State of North Carolina through the University of North Carolina at Chapel Hill.

Provide shall mean purchase, deliver, install, new, clean, completely operational, fully tested and ready for use.

SECTION 01 10 00 - SUMMARY

PART 1 GENERAL

1.01 REMOVALS

A. Contractor shall remove and deliver the following to Owner prior to start of work:
   1. Water fountains.
   2. Window AC units.
   3. Dehumidifiers.
   4. HHW filter feeder.
   5. Legacy DDC controllers and BAS components.
   6. Large control valves.
   7. COGEN condensate pump and motor control panel.
   8. HVAC units.

1.02 WORK BY OWNER

A. Items noted NIC (Not In Contract) will be supplied and installed by Owner before Final Acceptance.

B. Items noted OFCI (Owner Furnished, Contractor Installed) will be supplied by Owner and installed by Contractor.

1.03 CONTRACTOR USE OF SITE

A. Construction Operations: Limited to areas noted on Drawings.

B. Arrange use of site to allow:
   1. Work by Owner or by others.

C. Provide access to and from site as required by law and by Owner.

D. Do not obstruct roadways, sidewalks, or other public ways without permit.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 20 00 - PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Documentation of proposed changes in Contract Sum and Contract Time.

1.02 SCHEDULE OF VALUES

A. Submit a printed schedule that accurately reflects the fair market value of the several portions of the work in a form acceptable to the Architect.

B. Submit a printed schedule showing each item of work and using the Table of Contents of this Project Manual as a guide. Identify each line item with number and title of the specification Section, breaking down individual sections into discrete items of work to facilitate evaluation of completion.

C. For unit price work, identify quantities taken from the Contract Documents multiplied by the Contract unit price to achieve the total for the item.

D. Revise schedule to list approved Change Orders, with each Application For Payment.

1.03 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Present required information in typewritten form.

C. Form: AIA G702 Application and Certificate for Payment plus either AIA G703 Continuation Sheet or Contractor's electronic media driven form as continuation sheet.

D. Execute certification by signature of authorized officer.

E. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.

F. Submit three copies of each Application for Payment.

G. If off-site storage is permitted by the General Conditions and is agreed to by the Owner, provide affidavits in a form acceptable to the Owner attesting to off-site stored products.

H. When Architect requires substantiating information, submit data justifying dollar amounts in question.

1.04 SUBSTANTIATION OF COST OF PROPOSED CONTRACT MODIFICATIONS

A. Provide full information required for evaluation:
   1. Quantities of materials and the cost thereof including shipping to the site.
   2. Manhours of labor and hourly cost including payroll taxes, insurance, and benefits for each skill or labor classification.
   3. Quantities and costs of equipment, tools, and other material not incorporated into the work.
   4. Overhead and profit.
   5. Justification for any change in Contract Time.
   6. Credit for deletions from Contract, similarly documented.
   7. Other information requested by the Architect.

B. For Time and Material work, submit itemized account and supporting data as the work progresses and after completion of change, within time limits indicated in the Conditions of the Contract.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 22 00 - UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. List of unit prices, for use in preparing Bids.

B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

1.02 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

1.03 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.04 MEASUREMENT OF QUANTITIES

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Take all measurements and compute quantities. Measurements and quantities will be verified by Owner.

C. Assist by providing necessary equipment, workers, and survey personnel as required.

D. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

E. Measurement by Area: Measured by square dimension using mean length and width or radius.

F. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.

G. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work.

H. Contractor's Engineer Responsibilities: Sign surveyor's field notes or keep duplicate field notes, calculate and certify quantities for payment purposes.

1.05 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products not completely unloaded from the transporting vehicle.
   4. Products placed beyond the lines and levels of the required Work.
   5. Products remaining on hand after completion of the Work.
   6. Loading, hauling, and disposing of rejected Products.

1.06 SCHEDULE OF UNIT PRICES

A. A1 Repointing of Brick Masonry
   1. Section 04 09 20 - Masonry Replacement, Repair and Re-Pointing.
   2. Measurement: Wall area quantity, work in place.
   3. Payment: Per square foot.
   4. Include the following quantity in the Base Bid: Area as noted on Drawings.

B. A2 New Slate Roof Shingles

1. Section 07 31 26 - Slate Shingles.
2. Measurement: Plan quantity, work in place.
3. Payment: Per square foot.
4. Include the following quantity in the Base Bid: 50% of the existing roof area.

C. AB1 Pipe Insulation Abatement
1. Measurement: Pipe length quantity, measured before removal.
2. Payment: Per linear foot.
3. Include the following quantity in the Base Bid: Area as noted on Drawings.

D. C1 Rock Excavation and Disposal Off-Site
1. Division 31 Section.
2. Description: Excavation, loading, transport and legal disposal of materials, including all disposal fees.
3. Measurement: Cubic yard measured before removal. Excvation will be classified and quantities verified by a soils and materials engineer employed by the Owner.
4. Payment: Per cubic yard.
5. Include the following quantity in the Base Bid: 10 CY.

E. C2 Unsuitable Soils Excavation and Disposal Off-Site.
1. Description: Excavation, loading, transport and legal disposal of materials, including all disposal fees.
2. Measurement: Cubic yard measured before removal. Excvation will be classified and quantities verified by a soils and materials engineer employed by the Owner.
3. Payment: Per cubic yard.
4. Include the following quantity in the Base Bid: 50 CY.

F. C3 Replacement of Removed Rock or Unsuitable Soils with Aggregate Base Course In-Place.
1. Description: Certified ABC materials from contractor's off-site source. Excavation, loading, transport, transport, placement and compaction of ABC into void remaining from removed rock or unsuitable soil. Cost of removal or rock or unsuitable soil is included in other Unit Prices.
2. Measurement: Cubic yard of void to be filled. Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
3. Payment: Per cubic yard.
4. Include the following quantity in the Base Bid: 20 CY.

G. C4 Replacement of Removed Rock or Unsuitable Soils with N0. 57 Washed Stone In-Place.
1. Description: Certified #57 washed stone from contractor's off-site source. Excavation, loading, transport, transport, placement and compaction of #57 washed stone into void remaining from removed rock or unsuitable soil. Cost of removal or rock or unsuitable soil is included in other Unit Prices.
2. Measurement: Cubic yard of void to be filled. Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
3. Payment: Per cubic yard.
4. Include the following quantity in the Base Bid: 20 CY.

H. C5 Replacement of Removed Rock or Unsuitable Soils with Excavatable Flowable Fill In-Place.
1. Description: Excavatable flowable fill from contractor's off-site source. Excavation, loading, transport, transport, placement and compaction of flowable fill into void remaining from removed rock or unsuitable soil. Cost of removal or rock or unsuitable soil is included in other Unit Prices.
2. Measurement: Cubic yard of void to be filled. Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
3. Payment: Per cubic yard.
4. Include the following quantity in the Base Bid: 20 CY.

I. S1 Infill of Openings in Existing Floors (Opening size between 6" and 9")
1. Drawing: 2/S502.

2. Measurement: Plan quantity, work in place.
3. Payment: Per quantity of openings to receive infill.
4. Include the following quantity in the Base Bid: quantity as noted on the Drawings.

J. S2 Infill of Openings in Existing Floors (Opening size between 9" and 32")
1. Drawing: 2/S502.
2. Measurement: Plan quantity, work in place.
3. Payment: Per quantity of openings to receive infill.
4. Include the following quantity in the Base Bid: quantity as noted on the Drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 23 00 - ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description of Alternates.

B. Procedures for pricing Alternates.

1.02 ACCEPTANCE OF ALTERNATES

A. Alternatives quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted alternatives will be identified in the Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work to integrate the Work of each alternative.

1.03 SCHEDULE OF ALTERNATES

A. Alternate A1 - Aluminum Replacement Windows:
   1. Base Bid Scope: Restoration of existing metal windows and interior stools/trim as specified in Section 08 59 00, Installation of new interior storm panels as specified in Section 08 51 13.
   2. Alternate Scope: Aluminum replacement windows as specified in Section 08 51 13, new wood window stools as specified in Section 12 36 00, new interior wood trim as specified in Section 06 20 00.

B. Alternate A2 - Elevator Cab Interior Finishes:
   1. Base Bid Scope: No new elevator cab interior finishes.
   2. Alternate Scope: New elevator cab interior finishes as specified in Section 14 21 00.

C. Alternate A3 - Stair Landings Floor Finish:
   1. Base Bid Scope: Rubber tile flooring on top of existing floor finish at intermediate landings between Floors 01 and 03 of North and South stairs as specified in Section 09 65 00.
   2. Alternate Scope: Repair and refinish existing terrazzo flooring at intermediate landings between Floors 01 and 03 of the South stair; Remove existing flooring and install new terrazzo at intermediate landings between Floors 01 and 03 of the North stair as specified in Section 09 66 23.

D. Alternate A4 - Low-e Coating on New Storm Windows:
   1. Base Bid Scope: New storm windows without low-e coating as specified in Section 08 51 13.
   2. Alternate Scope: Provide low-e coating on the new storm windows as specified in Section 08 51 13.

E. Alternate C1 - Storm Drainage Improvements along West Side of Building:
   1. Base Bid Scope: Removal and replacement of 6" roof drain lines on west side of the bilding, per project plans and specifications.
   2. Alternate Scope: Additional storm drain remival and replacement along west side of building, per project plan and specifications.

F. Alternate PB-1 - Owner-Preferred Hydronic System Water Treatment.
   1. Base Bid Scope: Provide heating hot water chemical treatment and bypass chemical feeders as specified in Section 23 25 13 "Water Treatment for Closed-Loop Hydronic Systems".
   2. Alternate Scope: Provide closed-loop cleaning procedure by Chem-Aqua TB 3-001 and bypass chemical feeder Neptune FTF-5150DB.

G. Alternate PB-2 - Owner-Preferred Variable Frequency Drive (VFD) Cables.
   1. Base Bid Scope: Provide VFD cables as specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment".
   2. Alternate Scope: Provide Belden Classic VFD cables.

H. Alternate PB-3 - Owner-Preferred Butterfly Valves.

1. Base Bid Scope: Provide butterfly valves as specified in sections 23 05 23.13 "Butterfly Valves for HVAC Piping" and 23 80 01 "BAS Material and Devices".
2. Alternate Scope: Provide Siemens resilient seat butterfly valves.

I. Alternate PB-4 - Owner-Preferred Balancing Valves.
1. Base Bid Scope: Provide bronze, calibrated-orfice balancing valves as specified in Section 23 21 16 "Hydronic Piping Specialties".
2. Alternate Scope: Provide B&G Circuit Setter Plus or Circuit Setter Flo-Setter II.

J. Alternate PB-5 - Owner-Preferred Pressure Reducing Valves.
1. Base Bid Scope: Provide steam pressure reducing valves as specified in Section 23 22 16 "Steam and Condensate Heating Piping Specialties".
2. Alternate Scope: Provide Spence type-E main valve with type D pilot.

K. Alternate PB-6 - Owner-Preferred Mechanical Access Doors.
1. Base Bid Scope: Provide duct access doors as specified in Section 23 33 00 "Air Duct Accessories".
2. Alternate Scope: Provide Nailor Industries Model 0800 Type M1 Double Flange Frame for rectangular duct and Model 0895 for round duct.

L. Alternate PB-7 - Owner-Preferred Drinking Fountains.
1. Base Bid Scope: Provide drinking fountains as specified in Section 22 47 13 "Drinking Fountains".
2. Alternate Scope: Provide Elkay EZH20 LZSTL8WSLK.

M. Alternate PB-8 - Owner-Preferred Door Hardware.
1. Base Bid: Provide door hardware as indicated in Section 08 71 00 – Door Hardware.
2. Alternate: Provide Owner preferred-brand hardware as indicated below with balance of hardware as indicated in Section 08 71 00 – Door Hardware.
   a. Hinges — McKinney, ball bearing type
   b. Closers — LCN 4040XP series
   c. Mortise locks — Corbin-Russwin ML2000 series
   d. Exit devices — Von Duprin 99 series
   e. Overhead stops — Glynn-Johnson
   f. Auto door operators — LCN 4600 series
   g. Electronics — Von Duprin

N. Alternate PB-9 - Owner-Preferred Tile Carpet.
1. Base Bid: Provide products as indicated in Section 09 68 13.
2. Alternate: Provide Tile Carpeting for Classrooms types CT3 and CT4 basis of design products manufactured by J&J Flooring as indicated in Section 09 68 13.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction meeting.

B. Progress meetings.

1.02 ELECTRONIC DELIVERY OF PROJECT CORRESPONDENCE

A. Unless otherwise required or permitted, deliver project correspondence and documentation to the Architect in electronic form via "Newforma Info Exchange" provided by the Architect at no cost to the Contractor.

B. Unless otherwise required or permitted, employ pdf format and create pdf documents using standard text/graphic conversion software such as Adobe or Bluebeam and employ bookmarks throughout the document for ease of navigation; manually scanned documents are not acceptable.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Contractor shall schedule a meeting at the Project site prior to Contractor occupancy.

B. Attendance Required:
   1. Contractor.
   2. Owner.
   3. Architect.
   4. Contractor's Superintendent.

C. Agenda:
   1. Preliminary Contract Matters.
      a. Bonds, insurance certificates, and other preliminary contract compliance submittals.
      b. Notice to proceed.
      c. Schedule of values.
      d. Construction progress schedule.
      e. Submittal schedule.
      f. List of subcontractors.
      g. List of products.
      h. Posted construction documents (including addenda).
      i. Mobilization.
      j. Use of premises by Owner.
   2. Project Correspondence.
      a. Meeting notes.
      b. Architect’s Field Reports.
      c. Requests for Information.
      d. Submittals (product data, shop drawings, test reports, etc.).
      e. Product substitutions.
      f. Procedures for processing of ASI, PR, CCD, CO.
      g. Substantiation of proposed cost of contract modifications and substitution requests.
      h. Applications for Payment.
   3. Site.
      a. Temporary Utilities.
      b. Temporary facilities and services.

c. Staging/storage.
d. Contractor parking.
e. Owner Requirements (Badging, Housekeeping).
f. Testing Procedures.
g. Severe Weather Rules.
h. Security and housekeeping.
i. Waste removal and disposal.

4. Post Construction.
   a. Owner's requirements and occupancy prior to completion.
   b. Project close out procedures.
   c. Start-up, training, and O&M manuals.
   d. Inspection and acceptance of equipment put into service during construction period.
   e. Maintaining record documents.
   f. Releases (surety, waivers, etc.).
   g. Reducing retainage.
   h. Date of completion inspections required by the General Conditions, Date of Final Acceptance, Final Payment.
   i. 11-Month Warranty Review.
   j. Post-Contract Evaluation.

D. Architect will record minutes and distribute copies to Contractor and Owner.

3.02 PROGRESS MEETINGS

A. Progress meetings will be held at weekly intervals during the active construction period.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required: Job superintendent, major Subcontractors and suppliers, Owner, Architect, as appropriate to agenda topics for each meeting.

D. Agenda:
1. Review minutes of previous meetings.
2. Change Order Log.
   a. Effect of proposed changes on progress schedule and coordination.
3. Condemnation Log.
4. Quality Issues.
   a. Field observations, problems, and decisions.
5. Review of Work progress.
6. RFI Log.
7. Review of submittals schedule and status of submittals.
8. Review construction progress schedule.
   a. Planned progress during succeeding work period.
   b. Review of off-site fabrication and delivery schedules.
   c. Time Extension Requests (if any).
   d. Corrective measures to regain projected schedules.
9. Payment or Claim Issues.
10. Subcontractor Issues.
11. Contractor Application for Payment.
12. Identification of problems which impede planned progress.
13. Other issues Affecting the Work.
    a. Owner-Provided items (FFE); especially submittal or coordination data.
14. Scheduled pre-installation meetings.
15. Scheduled mock-ups.
16. Scheduled tests.
17. Any other items for discussion.

18. Is the Contractor being delayed because of any action or non-action by the Architect or Owner.
19. Next Meeting Date.
20. Other business relating to Work.

E. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.03 REQUESTS FOR INFORMATION (RFI)

A. When additional information concerning the Contract Documents is desired, the Contractor shall make a request to the Architect in the form of an RFI and shall include a detailed written statement that indicates the specific Drawing number or Specification paragraph number in need of clarification and the nature of the clarification requested.

B. The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed to by the Architect or, in the absence of agreement, with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

3.04 FOR REQUESTS FOR SUBSTITUTION, SEE:

A. Invitation to Bid.

B. General Conditions of the Contract for Construction.

C. Section 01 60 00 - Product Requirements.

D. Section 01 62 03 - Substitution Request.

3.05 FOR SUBMITTAL PROCEDURES, SEE:

A. Section 01 33 00 - Submittals.

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for submittals for review, information, and project closeout.

B. Timing and packaging of submittals.

C. Delivery of submittals.

1.02 SUBMITTALS

A. Submittal schedule.

B. List of proposed major products.

C. List of proposed subcontractors.

1.03 ELECTRONIC DELIVERY OF PROJECT CORRESPONDENCE

A. Unless otherwise required or permitted, deliver project correspondence and documentation to the Architect via "Newforma Info Exchange" provided by the Architect at no cost to the Contractor.

B. Unless otherwise required or permitted, employ pdf format and create pdf documents using standard text/graphic conversion software such as Adobe or Bluebeam and employ bookmarks throughout the document for ease of navigation; manually scanned documents are not acceptable.

1.04 DEFINITIONS

A. Product Data: Manufacturer’s standard published literature necessary to demonstrate compliance with specified requirements. Product data may include descriptions, illustrations, standard schedules, performance charts, brochures, and diagrams. Where product data covers a range of product values (e.g. thickness or other dimension, density, compressive strength, or other characteristics) product data or other documentation shall identify applicable products, models, options, values, and other data.

B. Shop Drawings: Drawings, diagrams, schedules and other data specially prepared for the project by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work. Where applicable, shop drawings shall indicate specific dimensions of products, configurations, utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Samples: Physical samples of actual product that illustrate functional and aesthetic characteristics of the product, materials, equipment, or workmanship to be provided in the project and that serve to establish standards by which compliance with the Contract Documents may be judged. Where samples are for selection from standard finishes, samples shall represent the full range of the manufacturer’s standard colors, textures, and patterns. Where samples are for verification of a proposed lot and contain a range of naturally occurring characteristics (e.g. wood veneer, stone, etc.), samples shall be representative of the run of material and in additional shall include the full range of anticipated variation.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format.
   1. Coordinate with Contractor's construction schedule.

2. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for initial product review, in-progress field data, project closeout), role and name of subcontractor if any.
3. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

3.02 SUBMITTALS FOR REVIEW

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product. Major products are the primary product(s) specified in each specification section.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. Proposed Subcontractors List:
   1. Submit list of subcontractors proposed and identify the portion of work assigned to each.
   2. Submit installer qualifications specified in respective specification sections.
   3. Submit within 15 days after date of bid opening.

C. When the following are specified in individual sections, submit them for review:
   1. Product data.
   2. Shop drawings.
   3. Samples for selection.
   4. Samples for verification.
   5. Delegated design data submittals, certifications, and approvals.
   6. Sustainable design submittals and reports (LEED).
   7. Other types when indicated in respective specification sections.

D. Architect's review is only for the limited purpose of checking for conformance with the information given and the design concept expressed in the contract documents.
   1. Architect's review is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. Architect's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Architect, of any construction means, methods, techniques, sequences or procedures. Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

E. Delegated Design: Where the contract documents provide performance and design criteria and require that design services, certifications, or approvals be provided by a licensed professional, said professional shall be entitled to rely on the adequacy and accuracy of the performance and design criteria in the contract documents and the Owner and Architect shall be entitled to rely on the adequacy and accuracy of the design services, certifications, and approvals provided by said professional. Architect's review is only for the limited purpose of checking for conformance with the information given and the design concept expressed in the contract documents.

F. Contractor is responsible for determining and verifying materials, field measurements and field construction criteria related thereto, and checking and coordinating the information contained within the submittal with the requirements of the Work and of the Contract Documents.

G. Samples will be reviewed only for aesthetic attributes such as color, pattern, and texture.

3.03 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.

6. Manufacturer's field reports.
7. Other types when indicated in respective specification sections.

B. Submit for Architect's delivery to Owner.

C. Action taken by the Architect on informational submittals (whether "approval" or other action) indicates only that the item has been received in the form required by the contract documents and that the Architect will transmit the item to the Owner for the Owner's records, but does not indicate that the Architect has verified the accuracy or adequacy of the contents of the submittal.

3.04 SUBMITTALS FOR PROJECT CLOSEOUT

A. When the following are specified in individual sections, submit them at project closeout:
1. Project record documents.
2. Operation and maintenance data.
3. Warranties.
4. Bonds.
5. Other types as indicated.

B. Submit for Owner's benefit during and after project completion.

C. Action taken by the Architect on project closeout submittals (whether "approval" or other action) indicates only that the item has been received in the form required by the contract documents, but does not indicate that the Architect has verified the accuracy or adequacy of the contents of the submittal.

3.05 TIMING AND PACKAGING OF SUBMITTALS

A. Submit complete, coordinated data. Partial submittals are not acceptable unless specifically exempted. For complex assemblies comprising components from two or more Specification Sections, submit data for all components of the assembly as a single, coordinated package.

B. Initial Product Information: For each Section of the Specifications, submit the initial product information listed below as a single package.
1. Product data.
2. Samples.
3. Installer and manufacturer qualifications.
4. Manufacturer's instructions.
5. Certificates, test reports, and inspection reports of standard plant runs that demonstrate compliance of proposed products with specified quality.
6. Similar submittals demonstrating quality of proposed products.

C. Shop Drawings and Design Data:
1. Submit Shop Drawings and Design Data for each Section of the Specifications as a single package.
a. Exception: Especially large quantities of drawings on large projects may be divided into individual submissions, such as package 1, 2, 3, etc.
2. Submit the following prior to placing final order for fabrication:
a. Detailed drawings prepared specifically for the project, for example drawings of concrete reinforcing, structural steel, curtain wall, equipment.
b. Calculations or other designs prepared specifically for the project.

D. In-Progress Reports: Multiple submittals permitted. Submit the following in a timely manner as the work progresses.
1. Certificates, test reports, and inspection reports of actual plant runs for this project (where required) or of tests and inspections made at the project site (earthwork, concrete, steel, etc.).
2. Similar submittals recording actual quality installed on-site.

E. Project Closeout Submittals: Submit the following for each Section of the Specifications as a single package:
1. Test reports and inspection reports of completed work.

2. Project record documents.
3. Operation and maintenance data.
4. Warranties and bonds.
5. Final certificates.
6. Similar submittals attesting to completed work.

3.06 DELIVERY OF SUBMITTALS

A. Initial Product Information, Shop Drawings, Design Data, and In-Progress Reports:
   1. Deliver documents electronically in pdf format.
   2. Small Size Documents:
      a. Sheet size either 8-1/2 x 11 or 11 x 17 inches; do not submit 8-1/2 x 14.
   3. Documents Larger than 11 x 17 Inches:
      a. Sheet size as necessary.

B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect. If not specified in individual specification sections, submit two samples.
   1. Retained samples will not be returned to Contractor unless specifically so stated.

C. Documents for Information:
   1. Deliver documents electronically in pdf format.

D. Documents for Project Closeout:
   1. Warranties, Bonds, and Executed Forms: Submit original (paper) executed documents plus two photocopies.
   2. Testing, Balancing, Start-Up, and Operations and Maintenance Manuals:
      a. Submit number of paper copies as specified in respective specification sections. If quantity is not so indicated, submit two copies.
      b. Submit two copies of thumb drive, CD, or DVD-ROM format disks containing pdf files that are indexed and organized by specification section.

E. Submittal Procedures:
   1. Transmit each submittal with approved form.
   2. Number each transmittal with CSI specification number and suffix in the approved format.
   3. Identify Project, Contractor, Subcontractor or supplier. Identify Specification Section number and pertinent drawing and detail number.
   4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
   5. Text of the Contractor's stamp shall not be effective to limit or reduce the Contractor's responsibilities for review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
   6. Schedule submittals to expedite the Project, and coordinate submission of related items.
   7. Schedule submittals for orderly review by the Architect. For each submittal for review, allow 15 days for Architect's review unless Architect notifies Contractor that additional time is necessary for review on account of Contractor's scheduling of simultaneous submittals.
   8. Identify variations from the Contract Documents.
   9. When revised for resubmission, identify all changes made since previous submission.
   10. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
   11. Submittals not requested will not be processed.

3.07 REQUESTS FOR SUBSTITUTION

A. Refer to the following:
   1. Invitation to Bid.
   2. General Conditions of the Contract for Construction.
   3. Section 01 60 00 - Product Requirements.

4. Section 01 62 03 - Substitution Request.

END OF SECTION

SECTION 01 33 29.02 - SUSTAINABLE DESIGN REPORTING - LEED V4

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General requirements for sustainable design reporting.

1.02 REPORTING REQUIREMENTS

A. Contractor must familiarize himself with the relevant reporting requirements and provide the necessary information and instruction to all subcontractors and installers.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for additional submittal procedures requirements.

B. Sustainable Design Documentation: The scope of required documentation is specified in this section and in applicable individual specification sections.

C. LEED v4 Prerequisites and Credits - Documentation is required for the following items:
   1. Waste Disposal Management: Periodic reports quantifying diversion of construction waste away from landfills and incineration facilities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROCEDURES

A. Submit sustainable design documentation required of Contractor, using procedures defined under Submittals for Information in Section 01 30 00.

B. Where an item of sustainable design documentation is specified, fill out and submit electronically the appropriate form(s), and/or use appropriate software.
   1. Fill out one line for each different brand name product and each different manufacturer of a lot of commodity products.
   2. Where required attachments are specified, attach the documentation.
   3. Mark each blank with the appropriate information; use "ATT" for items attached; if any item is not relevant use the code "NR"; if any item is not available use the code "NA".

C. Each form must be signed by the entity capable of certifying the information.
   1. Certification signatures must be made by an officer of the company.
   2. For products, certification must be made by the manufacturer not the supplier.
   3. For custom fabricated products, certification by the fabricator is acceptable.

D. Submit the completed forms in accordance with the requirements of Section 01 30 00, as information submittals.
   1. Give each form a unique submittal number.
   2. Do not combine sustainable design documentation with product data or shop drawing submittals.

END OF SECTION

SECTION 01 35 66.33 - SUSTAINABLE DESIGN PROJECT PROCEDURES

PART 1 GENERAL

1.01 PROJECT APPROACH

A. Contractor is not responsible for the application for formal Sustainability certification, nor for determination of methods of achieving sustainable design goals unless specifically so indicated.

B. Many of the sustainable design goals can be achieved only through intelligent design of the project and are beyond the control of the Contractor. However, achieving certain goals is dependent on products and procedures used for construction. To achieve Owner's goals, full cooperation of the Contractor and subcontractors is essential and therefore they must familiarize themselves with the relevant requirements, and provide the necessary information and instructions to product suppliers and installers.

1.02 RELATED REQUIREMENTS

A. General and Technical Sections: Sections that have requirements intended to achieve Sustainability Credits include, but are not limited to, the following:

B. DIVISION 1 - GENERAL REQUIREMENTS
   1. Section 01 33 29.12 - Sustainable Design Reporting - LEED v4.1: Requirements and procedures for sustainable design documentation.
   2. Section 01 57 19 - Temporary Environmental Controls.
      a. Basic construction procedures.
   3. Section 01 60 00 - Product Requirements.
      a. Definitions of:
         1) Bio-Based content.
         2) Cradle-to-Cradle.
         3) Environmental Product Declarations.
         4) GreenScreen Chemical Hazard Analysis.
         5) Health Product Declarations.
         6) Manufacturer's Inventory of Product Content.
         7) Recycled Content.
         8) Reused Products.
         9) Source Location.
         10) Sustainable forestry certified Wood.
      b. Regionally-sourced products.
         1) Contractor is not required to provide any particular minimum percentage of regionally-sourced products; however, Contractor is required to collect and submit information necessary to determine whether the material is eligible for application of cost multiplier for products sourced within 100 miles (160 Km) of the project site.
   4. Section 01 70 00 - Execution and Closeout Requirements.
      a. Dust control and basic surface drainage.
      b. Alterations procedures and selective demolition for preserving existing construction.
   5. Section 01 74 19 - Construction Waste Management and Disposal: Requirements for landfill diversion and reporting.
   6. Section 01 78 00 - Closeout Submittals: Maintenance and operation manuals for commissioned systems.
   7. Section 01 79 00 - Demonstration and Training.
      a. Demonstration of commissioned systems and equipment.
      b. Training of Owner's personnel.
   8. Section 01 91 13 - General Commissioning Requirements.
   9. Section 01 91 14 - Commissioning Authority Responsibilities.
      a. LEED Fundamental Commissioning.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROCEDURES

A. General: Conduct project management and construction operations in a manner consistent with, and in support of successful achievement of Owner's targeted certification level.

B. Sustainable Design Reporting: Comply with requirements of Section 01 33 29.12 - Sustainable Design Reporting - LEED v4.1.

END OF SECTION

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and standards.

B. Mock-ups.

C. Control of installation.

D. Tolerances.

E. Testing and inspection services.

F. Manufacturer's field services.

G. Defect assessment.

1.02 REFERENCES

A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008 (Reapproved 2019).

B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2017.

C. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry; 2022.

D. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2019.

E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2021.

F. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2021.

G. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components; 2016.

1.03 SUBMITTALS

A. Independent Testing Agency Qualifications:
   1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered engineer and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

B. Test Reports: After each test/inspection, promptly submit report directly to Architect and to Contractor. Include:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and specifications section.
   6. Location in the Project.
   7. Type of test/inspection.
   8. Date of test/inspection.
   9. Results of test/inspection.
   10. Conformance with Contract Documents.
   11. When requested by Architect, provide interpretation of results.

C. Manufacturer's Field Reports: Submit reports for Architect's information and benefit as contract administrator.
   1. Submit reports within 7 days of observation to Architect.

1.04 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard of date of issue specified in individual specification sections or, if none, the date current on the date of issue of the Contract Documents.

C. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.05 TESTING AND INSPECTION AGENCIES

A. As indicated in the respective specification section, Owner or Contractor will employ and pay for services of an independent agency to perform specified testing and inspection.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

C. Independent Agency Qualifications:
   1. Testing Agency: Comply with requirements of ASTM E329, ASTM E543, ASTM E699, ASTM C1021, ASTM C1077, ASTM C1093, and ASTM D3740 as applicable to the nature of the testing.
   2. Maintain a full time registered engineer on staff to review services.
   3. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

D. Owner and Contractor may self-perform (or delegate to their subcontractors) testing and inspection where services of an independent agency are not specified, and may do so in addition to such services where employment of an independent testing agency is specified.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

B. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

3.02 MOCK-UPS

A. Wherever a mock-up is required by the Contract Documents, construct mock-up and obtain the approval of the Architect before constructing the remainder of the Work.

B. Testing may be performed under provisions identified in the respective product specification sections and as otherwise directed by the Architect..

C. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

D. Approved mock-ups (in conjunction with the other requirements of the Contract Documents) shall be a standard of quality for judging the Work.

E. If mock-up is specified to be removed, remove and dispose of the mock-up only after mock-up has been approved by Architect and when directed to do so.

3.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

A. See individual specification sections for testing required.

B. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

C. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

D. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Provide reasonable notice to Architect and laboratory of expected time for operations requiring testing/inspection services to permit Architect and testing laboratory to schedule their activities.
   5. Employ and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.

F. Payment for re testing will be charged to the Contractor by deducting testing charges from the Contract Price.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections or when requested by the Architect, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of

equipment, and testing, adjusting, and balancing of equipment, and to initiate instructions when necessary.

B. Manufacturer's representatives shall report to the Architect any observations and site decisions or instructions given to the Contractor or installers that are supplemental or are contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to the Contract Documents.

B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment with the consent of the Owner will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary sanitary facilities.

B. Temporary closures.

1.02 TEMPORARY SANITARY FACILITIES

A. Provide and maintain temporary toilets. Provide at time of project mobilization.

B. Maintain daily in clean and sanitary condition.

1.03 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations .

B. Provide protection for plants designated to remain. Replace damaged plants.

C. Protect the vehicles of others, stored materials, site, and structures from damage.

1.04 FENCING

A. Design and location as indicated on Drawings.

1.05 EXTERIOR ENCLOSURES

A. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.06 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials prior to Final Acceptance inspection.

B. Clean and repair damage caused by installation or use of temporary work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 57 19 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction procedures to promote adequate indoor air quality after construction.

1.02 PROJECT GOALS

A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
   1. Cleaning of ductwork is not contemplated under this Contract.
   2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.

B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
   1. Furnish products meeting the specifications.
   2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017, with Addendum (2022).

B. SMACNA (OCC) - IAQ Guidelines for Occupied Buildings Under Construction; 2007.

1.04 DEFINITIONS

A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.

B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.

C. Particulates: Dust, dirt, and other airborne solid matter.

D. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.05 SUBMITTALS

A. Indoor Air Quality Management Plan: Describe, in detail, measures to be taken to promote adequate indoor air quality upon completion; use SMACNA (OCC) as a guide.
   1. Submit not less than 60 days before enclosure of building.
   2. Identify potential sources of odor and dust.
   3. Identify construction activities likely to produce odor or dust.
   4. Identify areas of project potentially affected, especially occupied areas.
   5. Evaluate potential problems by severity and describe methods of control.
   6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
   7. Describe cleaning and dust control procedures.

B. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.

C. Duct and Terminal Unit Inspection Report.

1.06 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: Independent testing agency having minimum of 5 years experience in performing the types of testing specified.

PART 2 PRODUCTS

2.01 MATERIALS

A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.

B. Auxiliary Air Filters: MERV of 8, minimum, when tested in accordance with ASHRAE Std 52.2.

PART 3 EXECUTION

3.01 CONSTRUCTION PROCEDURES

A. Prevent the absorption of moisture and humidity by adsorptive materials by:
   1. Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
   2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
   3. Provide sufficient ventilation for drying within reasonable time frame.

B. Begin construction ventilation when building is substantially enclosed.

C. If extremely dusty or dirty work must be conducted inside the building, shut down HVAC systems for the duration; remove dust and dirt completely before restarting systems.

D. Use of HVAC equipment and ductwork for ventilation during construction is not permitted:
   1. Provide temporary ventilation equivalent to 1.5 air changes per hour, minimum.
   2. Exhaust directly to outside.
   3. Seal HVAC air inlets and outlets immediately after duct installation.

E. Do not store construction materials or waste in mechanical or electrical rooms.

F. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.
   1. Inspect duct intakes, return air grilles, and terminal units for dust.
   2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
   3. Clean tops of doors and frames.
   4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
   5. Clean return plenums of air handling units.
   6. Remove intake filters last, after cleaning is complete.

G. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.

H. Use other relevant recommendations of SMACNA (OCC) for avoiding unnecessary contamination due to construction procedures.

END OF SECTION

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Prohibition of asbestos-containing materials.

C. Re-use of existing products.

D. Storage and protection.

E. Product option requirements.

F. Substitution requirements and procedures.

G. Procedures for Owner-Furnished-Contractor-Installed products.

1.02 RELATED REQUIREMENTS

A. Instructions to Bidders and General Conditions: Product options and substitution procedures.

B. Section 01 62 03 - Substitution Request: Substitution form.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.

B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.

C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by the Contract Documents.

B. Do not use products that contain 1 percent or more by weight of asbestos (asbestiform varieties of chrysotile (serpentine), crocidolite (riebeckite), amosite (cummingtonite-grunerite), anthophyllite, tremolite, or actinolite)) .

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only, without naming a manufacturer or brand name product: Use any product meeting those standards or description, and comply with the remaining requirements of the project.

B. Products Specified by Naming One or More Brand Name Products: Use one of the brand name products specified, and comply with the remaining requirements of the project.

C. Products Specified by Naming One or More Manufacturers: Use products of one of the manufacturers specified, and comply with the remaining requirements of the project.

D. Products Specified by Naming a "Basis of Design": Use the product named as "basis of design", or obtain the approval of the Architect of specific products by other manufacturers listed in the specification following the procedures specified for substitutions.

2.04 MANUFACTURER QUALIFICATIONS AND INSTALLER QUALIFICATIONS

A. The qualifications for manufacturers and for installers specified in the respective specification sections are requirements of the Contract.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

A. The Architect in the Architect's sole discretion may reject or take no action on a request for substitution.

B. The Architect may approve a request for substitution with the consent of the Owner.

C. For time restrictions on substitution requests see the Invitation to Bidders and the General Conditions.

D. Approval of substitutions after the award of contract may occur only by Contract Modification.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request complying with the requirements specified herein.

F. Substitution Submittal Procedure:
   1. Submit a request for substitution for consideration. Limit each request to one proposed substitution.
   2. Accompany requests with a completed Substitution Request form as specified in Section 01 62 03, and provide documentation required by that form.
   3. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   4. Accompany requests after the receipt of bids with complete documentation of cost (whether cost will increase, decrease, or remain the same) for both the specified item and the proposed item. Provide full information required for evaluation:
      a. Quantities of materials and the cost thereof, including shipping to the site.
      b. Manhours of labor and hourly cost including payroll taxes, insurance, and benefits for each skill or labor classification.
      c. Quantities and costs of equipment, tools, and other material not incorporated into the work.
      d. Overhead and profit.
      e. Credit for deletions from Contract, similarly documented.
      f. Justification for any change in Contract Time.
      g. Other information requested by the Architect.
   5. The Architect will notify Contractor in writing of decision to accept or reject request, and when approved will incorporate the change into the Contract Documents.

G. A request for substitution constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Will provide the same warranty for the substitution as for the specified product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.

3.02 PRODUCTS SUPPLIED BY OWNER

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.
   3. On delivery, inspect products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
   1. Review Owner reviewed shop drawings, product data, and samples.
   2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
   3. Handle, store, install and finish products.
   4. Repair or replace items damaged after receipt.

3.03 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Prevent contact with material that may cause corrosion, discoloration, or staining.

H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01 60 10 - PRODUCT REQUIREMENTS FOR SUSTAINABLE DESIGN

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Definitions of selected sustainable design terms.

B. Sustainable design-related product requirements.

C. These requirements are in addition to - not in lieu of - requirements specified in Section 01 60 00 and elsewhere in the Contract Documents.

1.02 SUBMITTALS

A. Sustainable Design Submittals: Items necessary to document use of sustainable construction materials, products, and practices.
   1. See Section 01 33 29.02 for Contractor's reporting necessary for achievement of targeted LEED v4 certification level.
   2. See Section 01 35 66.12 for Contractor's procedures necessary for achievement of targeted LEED v4 sustainability certification level.

1.03 DEFINITIONS

A. Bio-Based Content: Of vegetable or animal origin, not including products made by killing the animal.
   1. Determine percentage of bio-based content in accordance with ASTM D6866.
   2. Bio-based content must be sourced from a Sustainable Agriculture Network certified farm.

B. CAL (CDPH SM) v1.1: California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, v. 1.1–2010, for the emissions testing and requirements of products and materials.

C. Chain-of-Custody (COC): A procedure that tracks a product from the point of harvest or extraction to its end use, including successive stages of processing, transformation, manufacturing, and distribution.

D. Chain-of-Custody Certificates: Certificates signed by manufacturers and fabricators certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001.

E. Composite Wood and Agrifiber: Products made of wood particles and/or plant material pressed and bonded with adhesive or resin such as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates, and door cores.

F. Corporate Sustainability Report: A third-party verified report that outlines the environmental impacts of extraction operations and activities associated with the manufacturer’s product and the product’s supply chain.

G. Cradle-to-Cradle Certified: End use product certified Cradle-to-Cradle v2 Basic or Cradle-to-Cradle v3 Bronze, minimum, as evidenced by C2C (DIR).

H. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.
   1. Good: Product-specific; compliant with 1.
   2. Better: Industry-wide, generic; compliant with 4, or with 3, 2, 1, and 5; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
   3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.

4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or submit at least 5 declarations for products of the same type by other manufacturers in the same industry.

I. GreenScreen Chemical Hazard Analysis: Ingredients of 100 parts-per-million or greater evaluated using GreenScreen (METH).
   1. Good: GreenScreen (LIST) evaluation to identify Benchmark 1 hazards; a Health Product Declaration includes this information.
   2. Better: GreenScreen Full Assessment.
   3. Best: GreenScreen Full Assessment by GreenScreen Licensed Profiler.
   4. Acceptable Evidence: GreenScreen report.

J. Health Product Declarations (HPD): Complete, published declaration with full disclosure of known hazards, prepared using one of the 1 online tools.

K. Leadership Extraction Practices: Products that meet at least one of the responsible extraction criteria, which include: extended producer responsibility; bio-based materials; FSC wood products; materials reuse; recycled content; and other programs approved by sustainability certification system used for the project.

L. Manufacturer's Inventory of Product Content: Publicly available inventory of every ingredient identified by name and Chemical Abstract Service Registration Number (CAS RN).
   1. For ingredients considered a trade secret or intellectual property, the name and CAS RN may be omitted, provided the ingredient's role, amount, and GreenScreen Benchmark are given.

M. Multi-Attribute Certifications: Lifecycle-based environmental certifications that indicate that a product has undergone rigorous scientific testing, exhaustive auditing, or both, to prove its compliance with stringent, third-party, environmental performance standards. Third-party certifications include the following:
   1. ANSI/NSC 373: Sustainable Production of Natural Dimension Stone.
   2. BIFMA e3 - Furniture Sustainability Standard.
   3. Green Squared/ANSI A138.1 – 2011 v2 for ceramic tile, Glass Tiles and Tile Installation Materials.
   4. NSF/ANSI 140 – 2015 – Sustainability Assessment for Carpet.
   5. NSF 332 - Sustainability Assessment for Resilient Floor Coverings.
   6. NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric.
   7. NSF/ANSI 342 – 2014 Sustainability Assessment for Wallcovering Products.
   8. NSF/ANSI 347 - 2012a Sustainability Assessment for Single Ply Roofing Membranes.
   9. UL 100 first edition (2012) Standard for Sustainability for Gypsum Board and Panels.
   10. UL 102 Sustainability Assessment for Swinging Door Leafs.
   11. UL (STP) 106: Sustainability for Luminaires.
   12. UL (STP) 115: Sustainability for Thermal Insulation.

N. Rapidly Renewable Materials: Made from agricultural products that are typically harvested within a 10-year or shorter cycle.

O. Recycled Content: Determine percentage of post-consumer and pre-consumer (post-industrial) content separately, using the guidelines contained in 16 CFR 260.13.
   1. Previously used, reused, refurbished, and salvaged products are not considered recycled.
   2. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
   3. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of materials in the item.
   4. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
   5. Acceptable Evidence:
      a. For percentage of recycled content, information from manufacturer.
      b. For cost, Contractor's cost data.

P. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 100 miles (160.9 Km) from the Project site.

Q. Reused Products: Materials and equipment previously used in this or other construction, salvaged and refurbished as specified.
   1. Wood fabricated from timber abandoned in transit after harvesting is considered reused, not recycled.
   2. Acceptable Evidence: Information about the origin or source, from Contractor or supplier.

R. Source Location: Location of harvest, extraction, recovery, or manufacture; where information about source location is required to be submitted, give the postal address:
   1. In every case, indicate the location of final assembly.
   2. For harvested products, indicate location of harvest.
   3. For extracted (i.e. mined) products, indicate location of extraction.
   4. For recovered products, indicate location of recovery.
   5. For products involving multiple manufacturing steps, provide a description of the process at each step, with location.
   6. Acceptable Evidence:
      a. Manufacturer's certification.
      b. Life cycle analysis (LCA) performed by third-party.

S. Sustainably Harvested Wood: Solid wood, wood chips, and wood fiber certified or labeled by an organization accredited by one of the following:
   1. The Forest Stewardship Council, The Principles for Natural Forest Management; for Canada visit http://www.fsccanada.org, for the USA visit http://www.fscus.org.
   2. Acceptable Evidence: Copies of invoices bearing the certifying organization's certification numbers.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

A. Once the other requirements of the Drawings and Specifications are met, Contractor shall give preference to products that achieve the Projects sustainability goals, including but not limited to:
   1. If used on interior, have lower emissions, as defined in Section 01 61 16.
   2. If wet-applied, have lower VOC content, as defined in Section 01 61 16.
   3. Are extracted, harvested, and/or manufactured closer to the location of the project.
   4. Have longer documented life span under normal use.
   5. Result in less construction waste. See Section 01 74 19
   6. Are made of vegetable materials that are rapidly renewable.
   7. Are made of recycled materials.
   8. If made of wood, are made of sustainably harvested wood, wood chips, or wood fiber.
   9. If bio-based, other than wood, are or are made of Sustainable Agriculture Network certified products.
   10. Are Cradle-to-Cradle Certified.
   11. Have a published Environmental Product Declaration (EPD).
   12. Have a published Health Product Declaration (HPD).
   13. Have a published GreenScreen Chemical Hazard Analysis.

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 62 03 - SUBSTITUTION OR ALTERNATE MATERIALS REQUEST

TO: LORD AECK SARGENT PLANNING & DESIGN, INC.

Substitution of the following is hereby requested in accordance with the Instructions to Bidders and the General Conditions of the contract.

SPECIFIED PRODUCT:

SECTION NUMBER: PAGE NUMBER: PARAGRAPH NUMBER:

REASON FOR REQUESTING SUBSTITUTION; CHECK ONE OR MORE:

[ ] Contractor cannot provide the specified product, assembly, or method of construction within the Contract Time;

[ ] The request directly relates to an “or-equal” clause or similar language in the Contract Documents;

[ ] The request directly relates to a “product design standard” or “performance standard” clause in the Contract Documents;

[ ] The requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume;

[ ] The specified product or method of construction cannot receive necessary approval by an authority having jurisdiction, and Owner can approve the requested substitution;

[ ] Contractor cannot provide the specified product, assembly, or method of construction in a manner that is compatible with other materials and Contractor certifies that the substitution will overcome the incompatibility;

[ ] Contractor cannot coordinate the specified product, assembly, or method of construction with other materials and Contractor certifies they can coordinate the proposed substitution; or

[ ] The specified product, assembly, or method of construction cannot provide a warranty required by the Contract Documents and Contractor certifies that the proposed substitution provides the required warranty.

[ ] Other (explain):

PROPOSED PRODUCT INFORMATION:

Manufacturer:

Address:

Product trade name, model number, other characteristics:

Name of fabricator or supplier:

Address:

CHECK ONE:

[ ] The proposed product complies with the contract documents in every respect except for the specified manufacturer name or brand name or model number.

[ ] The proposed product material complies with the contract documents in every respect except for deviations which are as follows:

CHECK ONE:

[ ] No changes are required in other work or products if the substitute product is approved.

[ ] Changes will be required in other work or products, if the substitute product is approved, as follows:

MAINTENANCE SERVICES AND REPLACEMENT MATERIAL AVAILABILITY (IF APPLICABLE):

CHECK ONE:

[ ] No change in the Contract Sum is proposed.

[ ] Modification of the Contract Sum by adding $ _____ is hereby requested.

[ ] Modification of the Contract Sum by subtracting $ _____ is hereby requested.

CHECK ONE:

[ ] No change in the Contract Time is proposed.

[ ] Modification of the Contract Time by adding _____ calendar days is hereby requested.

[ ] Modification of the Contract Time by subtracting _____ calendar days is hereby requested.

CERTIFICATION:

The undersigned warrants to the Owner, to the Architect, and to other contractors and their subcontractors (if any) that the undersigned:

- has examined the Contract Documents for the project,

- has investigated the proposed product and has found it to be equal or superior in all significant respects to the specified product,

- will provide the same warranty for the proposed product as for the specified product,

- will coordinate the installation and make other changes which may be required for the work to be complete in all respects, including, redesign, additional components, and additional capacity required by other work affected by the change, and

- waives all claims for additional costs and time extensions which subsequently may become apparent and which are caused by the change.

- Will reimburse Owner for review or redesign services, when request is made after the award of contract.

ENCLOSURES:

The following complete information is enclosed for evaluation:

1. Product data on the proposed substitution.
2. A detailed cost breakdown itemizing the costs of the specified product and a detailed cost breakdown itemizing the costs of the proposed substitute product. Include each of the following:
   a. Quantities of materials and the cost thereof.
   b. Shipping to the site.

c. Manhours of labor and hourly cost including payroll taxes, insurance, and benefits for each skill or labor classification.
d. Quantities and costs of equipment, tools, and other material not incorporated into the work.
e. Overhead and profit.
f. Credit for deletions from Contract, similarly documented.

3. Justification for any change in Contract Time.
4. Other information requested by the Architect.

Other enclosures:

THIS REQUEST IS SUBMITTED IN THE NAME OF:

Company name:

Address:

Telephone:

BY:

Authorized Signature:

Date:

Typed Name:

Title:

END OF SECTION

SECTION 01 70 00 - EXECUTION REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.

C. Pre-installation meetings.

D. Cutting and patching.

E. Cleaning and protection.

F. Starting of systems and equipment.

G. Demonstration and instruction of Owner personnel.

1.02 PROJECT CONDITIONS

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

C. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

D. Rodent and Pest Control: Provide methods, means, and facilities to prevent rodents and pests and insects from accessing or invading premises.

E. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.03 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. Notify Architect sufficiently in advance of meeting date to allow for coordination with Architect's schedule.

B. Prepare agenda and preside at meeting:
   1. Review conditions of examination, preparation and installation procedures.
   2. Review coordination with related work.

C. Record minutes and distribute copies within two days after meeting to participants, with copies to Architect, Owner, participants, and those affected by decisions made.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 ALTERATIONS

A. Drawings showing existing construction and utilities are not record documents or precise surveys of actual conditions.
   1. Verify that construction and utility arrangements are as shown.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of alterations work constitutes acceptance of existing conditions.

B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
   1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
   2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.

C. Remove existing work as indicated and as required to accomplish new work.
   1. Remove items indicated on drawings.
   2. Relocate items indicated on drawings.
   3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
   4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.

D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
   2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
   3. Verify that abandoned services serve only abandoned facilities.
   4. Remove abandoned pipe, ducts, conduits, and equipment ; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

E. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch as specified for patching new work.

F. Adapt existing work to fit new work.

G. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect.

H. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.

I. Where a change of plane of 1/4 inch (6 mm) or more occurs in existing work, submit recommendation for providing a smooth transition for Architect review and request instructions.

J. Refinish existing surfaces as indicated:
   1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
   2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
   3. Patch as specified for patching new work.

K. Clean existing systems and equipment.

L. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

M. Do not begin new construction in alterations areas before demolition is complete.

3.06 CUTTING AND PATCHING

A. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.

B. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

C. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

D. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

E. Restore work with new products in accordance with requirements of Contract Documents.

F. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

G. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

H. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

I. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

J. Patch or replace surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. Repair substrate prior to patching finish. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

3.07 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

3.08 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.09 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

A. Demonstrate to Owner's personnel the start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

B. For equipment or systems requiring seasonal operation, perform demonstration for other season near the onset of the other season.

C. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.11 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.12 FINAL CLEANING

A. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.

B. Use cleaning materials that are nonhazardous.

C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces, dust and mop hard flooring.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean permanent washable filters and replace disposable filters of operating equipment.

F. Clean debris from roofs, gutters, scuppers, downspouts, overflow drains, and other elements of storm drain systems.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

END OF SECTION

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Owner may decide to pay for additional recycling, salvage, and/or reuse based on Landfill Alternatives Proposal specified below.

E. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
   1. Aluminum and plastic beverage containers.
   2. Corrugated cardboard.
   3. Wood pallets.
   4. Clean dimensional wood.
   5. Land clearing debris, including brush, branches, logs, and stumps; see Section 31 10 00 - Site Clearing for use options.
   6. Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
   7. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
   8. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (http://flooring.dupont.com) and Interface (www.interfaceinc.com) conduct reclamation programs.

F. Contractor Reporting Responsibilities: Submit periodic Waste Disposal Reports; report landfill disposal, incineration, recycling, salvage, and reuse regardless of to whom the cost or savings accrues; use the same units of measure on required reports.

G. Develop and follow a Waste Management Plan designed to implement these requirements.

H. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.

I. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 01 25 00 - Substitution Procedures.

B. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

C. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

D. Section 01 60 00 - Product Requirements: Waste prevention requirements related to product substitutions.

E. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

F. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

G. Section 31 10 00 - Site Clearing: Handling and disposal of land clearing debris.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Landfill Alternatives Proposal: Within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner, submit a projection of trash/waste that will require disposal and alternatives to landfilling, with net costs.
   1. Submit to Architect for Owner's review and approval.
   2. If Owner wishes to implement any cost alternatives, the Contract Sum will be adjusted as specified elsewhere.
   3. Include an analysis of trash/waste to be generated and landfill options as specified for Waste Management Plan described below.
   4. Describe as many alternatives to landfilling as possible:
      a. List each material proposed to be salvaged, reused, or recycled.
      b. List the proposed local market for each material.

c. State the estimated net cost resulting from each alternative, after subtracting revenue from sale of recycled or salvaged materials and landfill tipping fees saved due to diversion of materials from the landfill.

5. Provide alternatives to landfilling for at least the following materials:
   a. Bricks.
   b. Concrete masonry units.
   c. Asphalt paving.

C. Once Owner has determined which of the landfill alternatives addressed in the Proposal above are acceptable, prepare and submit Waste Management Plan; submit within 10 calendar days after notification by Architect.

D. Waste Management Plan: Include the following information:
   1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
   2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
   3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
   4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
   5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
   6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   4. Incinerator Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards (cubic meters), of trash/waste material from the project delivered to incinerators.
      c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   5. Recycled and Salvaged Materials: Include the following information for each:
      a. Identification of material, including those retrieved by installer for use on other projects.
      b. Amount, in tons or cubic yards (cubic meters), date removed from the project site, and receiving party.

c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.

6. Material Reused on Project: Include the following information for each:
   a. Identification of material and how it was used in the project.
   b. Amount, in tons or cubic yards (cubic meters).
   c. Include weight tickets as evidence of quantity.
7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 2 PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

A. See Section 01 60 00 and Section 01 25 00.

B. For each proposed product substitution, submit the following information in addition to requirements specified in Section 01 60 00:
   1. Relative amount of waste produced, compared to specified product.
   2. Cost savings on waste disposal, compared to specified product, to be deducted from the Contract Sum.
   3. Proposed disposal method for waste product.
   4. Markets for recycled waste product.

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.

2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 78 10 - SPECIAL PROJECT WARRANTY ON ROOFS AND WALLS

1.01 SUBMITTALS

A. The Contractor shall execute and submit to the Owner, prior to the date of Final Acceptance, a special project warranty in accordance with the General Conditions, in the form included hereinbelow. Such warranty shall likewise be executed by the Subcontractors, if any, performing the Work of the following Sections of the Specifications:
   1. Dampproofing and weather-resistant barriers on walls.
   2. Roofing.

1.02 SPECIAL PROJECT WARRANTY

A. Know all men by these presents, that the Contractor and the Subcontractor (hereinafter called Principals) jointly and severally are held and firmly bound unto the Owner, and that the Contractor and Subcontractor bind their executors and administrators, successors and assigns, jointly and severally, by these presents.

B. The condition of the above obligation is such that the Contractor has entered into a contract with the Owner (and the Subcontractors, if any, have entered into contracts with the Contractor) for the Project identified below.

C. The Principals warrant with respect to the said Work that for a period of five years from the date of Final Acceptance of the Project, the roof of the building or buildings, the roofs of covered passages, and the walls of the building or buildings (including components thereof comprising the exterior envelope) shall be absolutely watertight and free from all leaks, seepage or dampness, and that the Work is otherwise free of defects, and that the Principals shall, at no expense to the Owner, correct the Work in a manner compatible to the system and acceptable under industry standards and in accordance with the Contract Documents.
   1. When this instrument is executed by a Subcontractor, this agreement shall, insofar as the Subcontractor is concerned, extend only to the Work executed by said Subcontractor.
   2. The terms “roof” and “walls” for the purposes of this warranty shall include, but not be limited to, roof coverings, skylights, roof decking, deck sheathing, material used as a roof base or insulation over which or under which a roof is applied, roofing materials, promenade decks or any other work on the surface of the roof, flashing, base flashing, counterflashing, metal work, gravel stops, copings, roof expansion joints, vertical and horizontal expansion joints, below and above grade waterproofing (whether interior or exterior), below and above grade damp-proofing, through-wall flashing, damp course flashing, walls and wall cladding, and sealing of joints at openings in walls including but not limited to door perimeters, window perimeters, vents and pipe openings.

D. Defective Work for the purposes of this warranty and the General Conditions shall include, but not be limited to:
   1. Failure to maintain a water-tight condition as evidenced by entry of water:
      a. Into the building.
      b. Into substrates.
      c. Between membranes and their substrates.
      d. Within membrane assemblies.
   2. Development in membranes or in flashing of blisters, exposed felts, ridges, wrinkles, splits, warped insulation, or loose flashing; or failure of membranes or of flashing in any of the modes of cohesion, adhesion, tear, peel, etc., or to otherwise form a monolithic membrane that is solidly and firmly bonded to the substrate-whether or not, at the time of discovery, the membranes or flashing remain watertight.
   3. Exposure of membranes to traffic during the construction period.
   4. Failure of Work to conform to other requirements of the Contract Documents.

E. Explicitly deleted from the exclusions of the General Conditions for the purposes of this warranty are: insufficient maintenance, and normal wear and tear under normal usage; in as much as the Contractor acknowledges to the Owner and to the Architect that the quality of materials and workmanship required by the Contract Documents can reasonably be expected not to require maintenance, nor to suffer from normal usage, during and well beyond the warranty period.

F. Explicitly added to any exclusions that may be present in the General Conditions for the purposes of this warranty are:
   1. Damage from digging, trenching, or excavation by the Owner after the date of Final Acceptance of the Project.
   2. Defects or failures resulting from abuse by the Owner.
   3. Defects in design which the Principals shall have brought to the attention of the Owner in writing prior to installation of the Work, except, however, that the Principals shall not be responsible, insofar as liability under this warranty is concerned, for bringing to the attention of the Owner defects in design involving failure of the structural frame, load bearing walls, or foundations, nor shall the Principals be responsible for correction of leaks resulting from said failure.
   4. Damage caused by fire, tornado, hail, hurricane, acts of God, wars, riots, or civil commotion.

G. The Principals are not insurers nor are they guarantors of the suitability or adequacy of design. Any other provisions of this instrument to the contrary notwithstanding, the Principals shall not be required to remedy any unsuitable or inadequate design.

H. The obligation to correct defects shall include removal and replacement of other, non-defective Work (including but not limited to overburden such as soil, paving, plantings, interior finishes, and exterior finishes or materials), if necessary to access and repair the Work, or in the event such other Work is damaged as a result of such defects.

I. No provision of any manufacturer’s warranty required by other provisions of the Contract Documents, nor any provision of any other product, material, or workmanship warranty otherwise furnished by the Principals shall be effective to reduce or otherwise limit the Principals’ obligations under the present instrument.

J. No provision of the present instrument shall be effective to reduce or otherwise limit other rights to correction which the Owner may have under other provisions of the Contract Documents.

THIS PORTION LEFT BLANK INTENTIONALLY.

IN WITNESS WHEREOF, THE PARTIES HERETO HAVE CAUSED THIS INSTRUMENT TO BE DULY EXECUTED

THIS _____ DAY OF _____, 20___ .

PROJECT NAME:_____

PROJECT NUMBER:_____

AGREEMENT DATE:_____

THE CONTRACTOR:_____WITNESS:

BY:_____ _____

TITLE_____ _____

THE SUBCONTRACTOR: _____WITNESS:

BY:_____ _____

TITLE_____ _____

PERFORMING THE WORK OF SECTION:

_____ — _____

Instructions for execution:

If the firm is a partnership, all members of the partnership must execute.

If the firm is a corporation, the president must sign, the secretary must attest, and the seal of corporation must be affixed.

If the firm operates as a sole proprietorship, the proprietor must execute.

END OF SECTION

SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Commissioning is a systematic process to provide documented confirmation that building systems perform according to the criteria set forth in the design intent and satisfy the owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.

C. Commissioning is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on site is complete.
4. Verify that the Owner's operating personnel are adequately trained.

D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

E. Abbreviations. The following are common abbreviations used in the *Specifications* and in the *Commissioning Plan.* Definitions are found in Section 1.3.

A/E-	Architect and design engineers
CxA-	Commissioning authority
CC	Controls contractor
Cx-	Commissioning
Cx Plan-	Commissioning Plan document
EC-	Electrical contractor
FT-	Functional performance test
GC-	General contractor (prime)
MC-	Mechanical contractor
OR-	Owner's Representative
PC-	Prefunctional checklist
PM-	Project manager (of the Owner)
Subs-	Subcontractors to General
TAB-	Test and balance contractor

F. Related Sections:

1. Division 23 Section "Commissioning of HVAC" for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.

2. Division 26 Section "Commissioning of Electrical Systems" for commissioning process activities for integrated automation systems, assemblies, equipment, and components.

1.3 COMMISSIONING PROCESS

A. **Commissioning Plan**. The commissioning plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting the CxA will update the plan which is then considered the "final" plan, though it will continue to evolve and expand as the project progresses. The *Specifications* will take precedence over the *Commissioning Plan*.

B. **Commissioning Process**. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures, and OMs.
4. The CxA works with the Subs in developing startup plans and startup documentation formats, including providing the Subs with prefunctional checklists to be completed, during the startup process by the installing contractors.
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
6. The Subs, under their own direction, execute and document the prefunctional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing start-up of selected equipment. 48hr notice of intent to perform startup.
7. The CxA develops specific equipment and system functional performance test procedures. The Subs review the procedures.
8. The procedures are executed by the Subs, under the direction of, and documented by the CxA.
9. Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.
10. The CxA reviews the O&M documentation for completeness.
11. Commissioning is completed before Substantial Completion.
12. The CxA reviews and coordinates the training provided by the Subs and verifies that is was completed.
13. Deferred testing is conducted, as specified or required.

1.4 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, the Owner's Representative (OR) and representatives of the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. The Owners Representative.
4. Architect and engineering design professionals.

1.5 SYSTEMS TO BE COMMISSIONED

A. The following HVAC systems will be commissioned in this project.

1. All New Equipment
2. Controls
3. Air Handling Units
4. Exhaust Fans
5. Fan Coil Units
6. Testing, adjusting, and balancing

B. The following Electrical systems will be commissioned in this project.

1. Lighting Controls
2. Panel Schedule Review

PART 2 - EXECUTION

2.1 MEETINGS

A. Scoping Meeting (Cx Kickoff). Within 90 days prior to systems delivery, the CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to revise the *Commissioning Plan* to its "final" version, which will also be distributed to all parties.

B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs. These meetings may be as required. During the final 3 months of construction they may be held as frequently as one per week. Meetings attendance is required during warranty period to verify corrective action to outstanding deviancies, perform seasonal testing, and conduct ten month warranty walkthrough.

2.2 REPORTING

A. The CxA will provide regular reports to the OR, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the *Commissioning Plan.*

B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

D. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the OR, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

2.3 SUBMITTALS

A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.

1. Requested Submittals:
   a. Refer to Section 019113 Part 1.1.5 Systems to be Commissioned

B. The Commissioning authority will review and provide comment on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the OR, Owner Representative, or A/E

as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

C. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and approve them.

E. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.

2.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to all equipment to be commissioned, according to Section 1.15, Systems to be commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified PFCs and startup.

B. **General.** Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

C. **Start-up and Initial Checkout Plan.** The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Parties responsible for executing prefunctional performance tests are identified in the testing requirements in Sections 230800, and 260800.

1. The CxA develops prefunctional checklists and procedures. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
2. These checklists and tests are provided by the CxA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.
3. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CxA's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:

    a. The CxA's prefunctional checklists.

b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
c. The manufacturer's or contractors normally used field checkout sheets.
d. Any forms required for warranty submission

4. The subcontractor submits the full startup plan to the CxA for review and approval.
5. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
6. The full start-up procedures and the approval form may be provided to the OR for review and approval, depending on management protocol.

D. Execution of Prefunctional Checklists and Startup.

1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the OR, GC and CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. The CxA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved by the OR). In no case will the number of units witnessed be less than four on any one building, nor less than 20% of the total number of identical or very similar units.
3. For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CxA shall observe a sampling of the prefunctional and start-up procedures. The sampling procedures are identified in the commissioning plan.
4. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

E. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub. The CxA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the OR and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system to the OR using a standard form.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

2.5 FUNCTIONAL PERFORMANCE TESTING

A. This sub-section applies to all commissioning functional testing for all divisions.

B. The general list of equipment to be commissioned is found in Section 019113, Part 1 1.5.

C. The parties responsible to execute each test are listed with each test in Sections 230800 and 260800.

D. **Objectives and Scope.** The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

1. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested. Specific modes required in this project are given in Sections 230800 and 260800

2. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements in Sections 230800 and 260800.

3. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test, shall provide limited assistance to the CxA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.

4. The CxA shall review owner-contracted, factory testing or required owner acceptance tests which the CxA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.

5. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

6.

E. Test Methods.

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. Sections 230800 and 260800 specify which methods shall be used for each test. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the OR. This may require a change order and adjustment in charge to the Owner. The CxA will determine which method is most appropriate for tests that do not have a method specified.

2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
5. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
8. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

F. **Coordination and Scheduling.** The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the OR, GC and affected Subs. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.

1. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

2.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. **Documentation.** The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these

forms are provided to the OR for review and approval and to the Subs for review. The CxA will include the filled out forms in the O&M manuals.

B. Non-Conformance.

1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the OR on a standard non-compliance form.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the OR.
4. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.

    a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
        1) The CxA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA submits the non-compliance reports to the OR for signature, if required. A copy is provided to the Sub and CxA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
        2) The CxA reschedules the test and the test is repeated.

    b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

        1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the OR and to the Sub representative assumed to be responsible.
        2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
        3) The CxA documents the resolution process.
        4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.

5. Cost of Retesting.

    a. The cost for the *Sub* to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
    b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CxA and OR will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CxA's time

for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.

c. The time for the CxA and OR to direct any retesting required because a specific *prefunctional* checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.

6. The Contractor shall respond in writing to the CxA at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
7. The CxA retains the original non-conformance forms until the end of the project.
8. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

C. **Failure Due to Manufacturer Defect.** If 10%, or five, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the OR. In such case, the Contractor shall provide the Owner with the following:

1. Within one week of notification from the OR, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the OR within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The OR will determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples of the proposed solution will be installed by the Contractor and the OR will be allowed to test the installations for up to one week, upon which the OR will decide whether to accept the solution.
5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

D. **Approval.** The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA and by the OR, if necessary. The CxA recommends acceptance of each test to the OR using a standard form. The OR gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

2.7 DEFERRED TESTING

A. **Unforeseen Deferred Tests.** If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the OR. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. **Seasonal Testing.** During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

2.8 WRITTEN WORK PRODUCTS

A. The commissioning process generates a number of written work products described in various parts of the *Specifications.* The *Commissioning Plan—Construction Phase,* lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	Developed By
1. Final commissioning plan	CxA
2. Cx meeting minutes	CxA
3. Commissioning schedules	CxA with GC
4. Equipment documentation submittals	Subs
5. Sequence clarifications	Subs and A/E as needed
5. Prefunctional checklists	CxA
6. Startup and initial checkout plan	Subs and CxA (compilation of existing documents)
7. Startup and initial checkout forms filled out	Subs
8. Final TAB report	TAB
9. Issues log (deficiencies)	CxA
10. Commissioning Progress Record	CxA
11. Deficiency reports	CxA
12. Functional test forms	CxA
13. Filled out functional tests	CxA
14. O&M manuals	Subs
15. Commissioning record book	CxA
16. Overall training plan	CxA and OR
17. Specific training agendas	Subs
18. Final commissioning report	CxA
19. Misc. approvals	CxA

END OF SECTION 01 91 13

UNC Chapel Hill Bingham Hall Renovation

Chapel Hill, NC

Commissioning Plan

7/1/2023

Tom Foster, Jr.

Table of Contents

OVERVIEW

The purpose of the Commissioning Plan is to provide a clear and concise roadmap for the implementation of the commissioning process and to provide a record of the results of the commissioning process. Since the Commissioning Plan contains the results of the process it can be considered a living document where the results are added throughout the process. Therefore, to simplify the upkeep of the document, the basic process and procedures to be followed throughout the project are detailed in the main body of the Commissioning Plan. The materials and information that is developed during the commissioning process are included in Cx Alloy

This Commissioning Plan has been specifically developed for UNC Chapel Hill Bingham Hall Renovation. Since the Commissioning process was initiated during the design phase, the process and procedures detailed in this Commissioning Plan have been tailored to this project to integrate with the current processes and procedures already implemented for the design and construction of the center. Therefore, this Commissioning Plan should not be applied to other commissioning projects.

As detailed above, the structure of this Commissioning Plan is a main body and appendices. The specific sections include:

- Commissioning Process Description: This section provides a detailed description of the tasks to be accomplished during the commissioning process. The information is tailored for the Admissions Building project focusing specifically on what must be accomplished during the design, construction, turnover, and operation phase.

- Roles and Responsibilities: The roles and responsibilities of each commissioning team member are clearly defined in this section. The goal of this section is to have each individual understand what they must do and how they fit into the entire process.

- Communication Structures: The communication paths to be used by the commissioning team members are detailed in this section.

- Contact information: Proper communication is critical for the success of any project. In this section, the contact information for the commissioning team members.

- Commissioned Systems and Equipment: The commissioned systems include those that are in the Commissioning WorCx's contract. These systems were expanded using the drawings and specifications to develop a detailed listing of each type of equipment in each system to be commissioned.

- Commissioning Process Schedule: There are specific sequences of events that occur during the commissioning process. These events are detailed in this section. In addition, details on the requirements for the commissioning activities are included within this section.

Summary of Revisions

The following is a summary of the revisions made for each version of the Commissioning Plan:

- 7/1/2023: Initial version of the Commissioning Plan.
- _____: First revision and update of the Commissioning Plan.
- _____: Second revision and update of Commissioning Plan, inclusion of revised OPR and BOD.
- _____: Third revision, inclusion of revised OPR and BOD, revision of plan to latest format.

Commissioning Process Description

The commissioning process for UNC Chapel Hill Bingham Hall Renovation began in the early stages of the design phase. As a result, it was still possible to complete most of the design phase commissioning tasks. The Commissioning plan includes the tasks that have been completed to date during the design, construction, turnover, and operation phases.

The intent of this section is to document how the tasks are accomplished as part of the commissioning effort for this project. This information is prescriptive and stepwise in nature to focus the commissioning efforts on verifying that the Owners Project Requirements have been met. Details on the results of actually accomplishing the tasks are contained in Cx Alloy

The key phases and commissioning tasks that have been or will be accomplished for the Golf House are detailed in the following sections.

Design Phase

The commissioning process was initiated early in the design phase. The tasks normally accomplished during the design phases are:

- Develop the Owners Project Requirements (OPR)
- Develop Commissioning Specifications
- Conduct a Design Reviews
- Develop the Basis of Design
- Develop initial commissioning plan (this document)

Develop the Owners Project Requirements (OPR)

The Owners Project Requirements (OPR) document is a condensed collection of vital information about a construction project. The document is intended for a wide audience, including the owner, design team, construction team, operation and maintenance staff, future renovation teams, and anyone who needs access to the original project information. The Owners Project Requirements are not a substitute for traditional architectural programming. It does contain some programming information, such as space usage, but it also contains the owner's goals, expectations, performance criteria, and (if necessary) records of decisions and trade-offs made during design and construction. Therefore, the Owners Project Requirements can be considered a living document because it is updated during design, construction and occupancy.

Since the design process was already underway when the commissioning process was started, the Owners Project Requirements for UNC Chapel Hill Bingham Hall Renovation had already begun to be defined by the A/E. Commissioning WorCx's role is to develop the information provided by the A/E and others into a formal

document, survey the key stakeholders for additional information, and request clarification to obtain a complete document.

Develop Commissioning Specifications

As the project was still in the early design phase when the commissioning process began, the Commissioning specifications were integrated into the overall specifications for the project. A general description of the commissioning process for the project, including commissioning meetings, submittals, O&M manuals, construction checklists, functional performance testing, and balance verification, as built drawings, and training, is contained in Section 01 91 13 of Division 1.

Specific information on the commissioning tasks for the appropriate contactors are identified in the individual specification sections of Divisions 22 through 26 for the various systems and equipment that will be commissioned.

Suggested revisions to the specifications to incorporate the commissioning requirements were provided to the A/E and Owner.

Conduct Design Reviews

Normal three planned design reviews of the specifications and drawings will be conducted: one at schematic design, one at Design Development & 95% design development documents. The remaining review will be of the construction documents, which will be done at the initiation of commissioning. The reviews focused on the systems that will be commissioned, along with the items related to the building in general, such as the Division 1 specifications. For each review, comments will be provided to the owner's representative and A/E. In addition, two design review meetings are planned.

The detailed comments developed during the design review will focus upon the following five criteria:

- Operability / Functionality: The design was reviewed for operability and functionally to insure that, when constructed, the systems and equipment are able to provide the desired end result for the building occupants (i.e.,) heating, cooling, lighting, etc.) in a reliable, effective, and efficient manner.

- Maintainability / Accessibility: The design was reviewed for maintainability and accessibility of systems and equipment because the Owner's facility maintenance staff will need to operate and maintain the building. To do so, they need clear documentation of the installed systems and easy access to the installed equipment and systems. The design drawings should provide clear documentation on how to construct the building, including clearly documenting that all equipment is accessible for proper maintenance. This will result in clear operations and maintenance documentation when the building is completed, allowing the Owner's facility maintenance staff to operate and maintain the building productively.

- Indoor Air Quality: The design was reviewed for indoor air quality concerns (including thermal comfort, humidity control, and control of pollutants) to help ensure that the building provides a safe and comfortable environment for the building occupants.

- Project Schedule / Constructability: The design was reviewed for impact on the project schedule and the ability to construct the system shown. To complete the project on time, the design documentation must be clear to prevent the need for additional time requests for information and change orders.

- Energy Efficiency / Sustainability: The design was reviewed for energy efficiency and Environmental impact.

Develop Basis of Design

The Basis of Design Document is a companion to the Owners Project Requirements and provides information on how the Owners Project Requirements are to be achieved, either through the development of the design documents or implementation during construction or operation. The "Supporting Documents" developed and submitted by the A/E team documents most of the calculations and reasons behind the design choices made. Commissioning WorCx will review these documents and provide comments and request additional information that has not been documented so the limitations of the systems are known and can be conveyed to the operators and users of the building and any design teams hired for future renovations or expansions.

Commissioning WorCx will also gather the available information from the drawings, specifications and "supporting documents" and insert this information into a Basis of Design summary template. The Basis of Design summary template will be provided to the A/E so that additional information can be inserted. The "supporting documents", basis of design summary, drawings, and specification together establish the Basis of Design.

Develop Initial Commissioning Plan

The development of the initial commissioning plan entails the creation of the plan, including all initial information that is available, documentation of communication structures for the project, documentation of the roles and responsibilities and the commissioning schedule. The sections described below are contained in the body of the commissioning Plan following the description of the commissioning process (this section).

Roles and Responsibilities: The roles and responsibilities of each commissioning team member are clearly defined in this section. The goal of this section is to have each individual understand what the must do and how they fit into the entire process.

Communication Structures: The communication structures focus on how questions are answered, problems resolved, and how documentation should flow through the system, including the time required for turn-around or resolution. Specifically, the communication structures for requests for information (RFI), change orders, submittals, meeting minutes, and dispute resolution are defined for the project.

Contact Information: The contact information is provided so that once the roles and responsibilities and communication structures are known, the project team members are able to contact each other.

Commissioned Systems and Equipment: The commissioned systems include those that are in Commissioning WorCx's contract. Using the drawings and specifications, a detailed listing was developed of each type of equipment that is associated with the systems to be commissioned. Also included are the commissioning steps that will be accomplished for each type of equipment.

Commissioning Process Schedule: The commissioning process schedule section details the items related to commissioning and how they fit into the overall project schedule.

The initial commissioning plan will be provided to the owner's representative, A/E, and general contractor in electronic format (PDF). Commissioning WorCx will send updates to the commissioning plan electronically via e-mail. Each holder of a copy of the commissioning plan will be responsible for updating their binder.

Construction Phase

The tasks to be accomplished during the construction phase include: conduct pre-construction meetings, review contractor submittals, identify and track commissioning process issues, develop and use construction checklists, develop site visit and commissioning progress reports, review final documentation, and conduct initial training.

Conduct Pre-Construction Meeting

The pre-construction meeting will review the commissioning process tasks the selected contractors are responsible for on this project. Also, a copy of the commissioning plan will be presented to and reviewed with the contractors during the meeting. The main goal of the commissioning portion of the pre-construction meeting will be to introduce the members of the commissioning team, establish communication lines and methods, review the commissioning requirements (both specifications and commissioning plan) and to provide an advanced look at the first few tasks that will be completed and when they will occur in the schedule.

As the project nears the end of the design process, the pre-construction meeting will soon be scheduled. Once the meeting has been scheduled, the tasks to be accomplished by Commissioning WorCx for the meeting are:

- Develop and distribute an agenda for the commissioning portion of the meeting to the owner and A/E. The agenda should include the time, place, items to be discussed, required attendees and the duration of the meeting.

- Modify and distribute agenda to attendees, prior to the meeting if possible

- Meeting day:
  - Have a sign-up sheet with name, company, phone and e-mail columns
  - Have copies of presentation ready for distribution
  - Answer questions following the presentation

Review Contractor Submittals

The first major interface Commissioning WorCx will have with the contractors is in reviewing their submittals for completeness and ability to meet the owner's requirements. Sampling of the submittals is used to enable Commissioning WorCx to focus efforts on evaluating the submittals beyond the specifications, especially for those instances where the Basis of Design (manufacturer and/or model) has changed. Commissioning WorCx's submittal review comments will be provided to the A/E, who will integrate the comments with their comments to provide clear feedback to the contractors.

Identify and Track Commissioning Process Issues

Throughout the commissioning process Commissioning WorCx will identify and track the resolution of commissioning process issues, which are defined as a failure to meet the owner's project requirement. Commissioning issues are documented better than traditional issues, allowing for better tracking and helping the entire project team avoid problems at the end of construction. For example, the issues database includes the cost to resolve each issue identified and the savings achieved as a result of resolving the issue. This cost information

shows the value commissioning contributed to the project, i.e., costs that the owner, A/E and/or contractor would incur if the issues were not identified and resolved as a result of the commissioning process.

By estimating the order of magnitude of the costs and savings associated with each issue (including O&M costs, energy savings, and redesign or reconstruction costs), the project team is provided with feedback on the value of commissioning.

Although all issues that occur during a project should be recorded, Commissioning WorCx will determine which issues to include in the cost analysis. Possible reasons for excluding a particular issue from a cost analysis could be lack of adequate cost information, negligible effects on the project outcome, or commissioning playing a minimal role in the issue. Costs will be determined based upon Commissioning WorCx's professional judgment and may include, but is not limited to, actual implementation costs (if a change order is required), industry reference materials such as RS Means, and calculations of energy use or additional maintenance labor. Commissioning WorCx will provide periodic updates via email to the owner's representative, A/E, and the contractors on issues in the process of being resolved.

Outstanding and resolved issues will be added to the issues log in the commissioning plan during the periodic updates.

Develop and Use Construction Checklists

The construction checklists are developed by Commissioning WorCx in Cx Alloy, an online commissioning software, maintained by the general contractor, and used by the general contractor and subcontractors. The intent of construction checklists is to convey pertinent information to the installers regarding the Owners Project Requirements (concerns on long term operation of the facility and systems, energy efficiency, etc.).

The checklists are structured to be short and simple by focusing on key elements. When information is known (submitted manufacturer, model, etc.), this information is included on the checklist when it is provided by the contractors. The checklists track the equipment from when it is delivered to the job site until the point that the system/component is started up and is operational. This includes testing, adjusting, and balancing (TAB) and control system tuning.

The development of the construction checklists takes close coordination between Commissioning WorCx and contractors to maximize the benefits of the checklists as noted below:

- CxA identifies components and systems for which checklists are required.
- CxA reviews owner's requirements for key success criteria.
- CxA reviews specifications and submittal information for key requirements.
- CxA sets up database with basic equipment information.
- CxA develops sample checklists.
- CxA provides sample checklists to owner and contractors for review.
- CxA fills in make and model information for checklists once submittals are approved.
- CxA finalizes checklists based upon owner and contractor feedback.
- CxA prints checklists.
- CxA sends checklists and tracking database to general contractor for distribution.

Once the checklists have been developed and provided to the general contractor, Commissioning WorCx will review the completion of the checklists periodically during their site visits. The Results of the review will be

included in the site visit report and provided to the contractors, owner, And A/E through Cx Alloy, which will allow the building team access to real time updates and have transparent communication throughout the duration of the project .

Develop Site Visit and Commissioning Meeting/ Progress Reports

Following each site visit by Commissioning WorCx, a site visit report will be prepared and distributed via email to the owner's representative, A/E and contractors. Commissioning meetings will be held either before or after regularly scheduled project coordination meetings. If a commissioning meeting was held during the site visit, the meeting minutes will be included in the site visit report.

Items which may be included in the site visit reports are construction issues, access and maintenance issues, energy efficiency issues, and other issues relating to the project's requirements and overall success. Items in the report should be brought to Commissioning WorCx's attention within one week of the report being sent.

Review O&M Manuals

The review of the O&M manuals will focus on verifying that the manuals have all the information required to properly install, operate, maintain, and troubleshoot the various system components, including key full and part-load data. In addition, the O&M Manual reviews will verify that the organization and structure of the manuals meet the owner's requirements.

Conduct Review of As-Built Drawings

The review of the as-built drawings will focus on verifying the accuracy of the locations of the main duct and piping runs, and equipment locations. The review will be general in nature, i.e., the drawings will be reviewed to see if, for example, the duct shown as running along the outside wall of the corridor is in fact along the outside wall and will be conducted in coordination with site visit activities by Commissioning WorCx.

TAB Report Verification

The TAB report will be reviewed to verify all of the equipment was tested, final balanced readings are within the specified range from the design values, and to verify the report is presented in an organized and complete manner. In addition, Commissioning WorCx, with the assistance of a technician provided by the TAB contractor, will verify 10% to 20% of the TAB report.

Conduct Initial Training

During construction, initial training will be held to provide a general orientation of the building systems to the O&M staff. The main goal of the initial training will be to provide a brief walk-through of the building to familiarize the O&M staff with the general layout of the systems, prior to the equipment being covered up by the installation of the ceiling and other finishes.

The following tasks are accomplished during the construction phase when preparing for and presenting training:

- Identify training requirements from specifications.
- Hold workshop with O&M staff to determine their needs for the training hours.
- Develop initial training agendas with owner.
- Review agendas with contractors.
- Review contractor final training agenda and training materials.
- Attend training workshops.
- Evaluate success of training and knowledge retention of attendees.

Turnover Phase

A formal turnover phase for UNC Chapel Hill Bingham Hall Renovation is used in the commissioning process to help facilitate the closeout of the project and help minimize building systems performance problems upon occupancy. The two items that are critical to this phase are the completion of functional testing and the completion of additional training.

Conduct Functional Performance Testing

Functional performance testing takes over where the construction checklists ended. The intent of functionally testing the system/ building as a whole is to evaluate the ability of the components in a system to work together to achieve the owner's requirements. For functional testing to provide valid results, the individual components and systems have to be verified to be operating properly (construction checklists). This includes individual control loops, point-to-point testing, and capacities (testing, adjusting, and balancing).
Functional performance tests will be developed once all submittals for commissioned systems and equipment are accepted. The tasks to be completed to develop and implement the functional performance testing are:

- Review project requirements and identify the key success criteria that require verification.
- Review submittals for equipment restrictions and testing procedures.
- Review specifications to identify scope of contractor testing.
- Develop draft functional test procedures.
- Review draft procedures with owner and contractors.
- Finalize functional test procedures.
- Implement functional tests (contractors perform tests with Commissioning WorCx witnessing and recording results).
- Evaluate results.
- Retest if necessary.
- Write report and conclusions.

Conduct Additional Training

Training is continued through the turnover phase according to the schedule developed during the construction phase. The focus of the training during the turnover phase is significantly more detailed than during the construction phase and will include the required information for the O&M staff to properly operate, maintain, troubleshoot, and optimize the facility.

During additional training, Commissioning WorCx will review the contractor's training agenda, and training materials, if any updates have been made since the initial training. Also, Commissioning WorCx will attend the training sessions and evaluate the effectiveness of the training.

Conduct Transition Meeting

The final task of this phase is the coordination of the formal transition meeting facilitated and coordinated by Commissioning WorCx. This meeting is intended to provide a formal transition point from contractor operation of the facility to owner operation. During this meeting all final documentation will be presented (record drawings, O&M manuals, training materials, etc.) warranty requirements will be reviewed, and final acceptance of the functional performance test will be accomplished. Agenda, attendance sheet, and meeting minutes for the transition meeting are to be included on Cx Alloy

Operation Phase

During the first year of operation, the commissioning process continues with additional functional testing for seasonal operation, warranty reviews, and the lessons learned workshop. The following is a detailed description of these tasks.

Conduct Seasonal Testing

Due to weather conditions, not all systems in the building will be able to be tested at or near full load during the turnover phase functional performance testing. Therefore, seasonal functional testing is required, and will be carried out in accordance with the procedures developed during the turnover phase.

Prepare Preliminary Commissioning Report

Following owner occupancy of the facility, Commissioning WorCx will provide a preliminary report detailing the results and findings of the commissioning process prior to occupancy. For simplicity the report will be generated from this commissioning plan with the exception that an executive summary, including a project summary, will be added to Cx Alloy and will be reviewed for completeness and updated as required.

Conduct Warranty Review

At the 10-month point of occupancy, the operation of the system and components is critically reviewed by Commissioning WorCx and the owner to identify any items that should be repaired or replaced under warranty. Accomplishing the warranty review requires the following tasks be completed:

- Review warranties.
- Identify items required for compliance.
- Develop site visit strategy for warranty review.
- Schedule site visit.
- Accomplish warranty review.
- Document results and transmit recommendations to owner and contractors.

Conduct Lessons Learned Workshop

The next task to be accomplished during the commissioning process is the convening of a lessons learned workshop. The intent of this workshop is to bring back all of the key stakeholder representatives on the project (owner, A/E, contractors, Commissioning WorCx, O&M staff, and occupants) to identify means of improving the next project. This meeting is facilitated by a non-entity (Commissioning WorCx, but not any of the key project staff), since all parties that are involved with the building must be a participant.

In order to obtain honest feedback from each individual the nominal group technique will be used for this task.

The steps to be taken in accomplishing this task are:

- Develop agenda and provide to owner for review.
- Develop final agenda and questions.
- Distribute agenda to attendees.
- Develop handouts and presentation materials.
- Send out reminder 1 week prior to the event.
- Convene workshop.
- Summarize results and transmit to attendees.
- Review processes and procedures and implement recommendations.

Prepare Final Commissioning Report

Following the completion of all commissioning activities, Commissioning WorCx will update the preliminary commissioning report detailing the results and findings of the commissioning process for all phases. Copies of the report will be distributed to the owner, A/E and contractors.

Roles and Responsibilities

Each party involved in the design and construction of UNC Chapel Hill Bingham Hall Renovation has a unique role in the project and is dependent on the other parties to achieve a successful project.

The owner's representative is responsible for managing the overall project from planning to turnover and for overseeing contractual obligations of the contractors and Commissioning WorCx.

The role of the A/E is to develop quality construction documents that will allow the contractors to construct the building and its associated systems. The A/E is also responsible for reviewing and approving the shop drawings, O&M manual, and other items that are submitted by the contractors.

The role of the contractors and subcontractors is to construct a quality building and associated systems that meet the owner's requirements as indicated on the construction documents.

The role of Commissioning WorCx is to act as an independent third party on behalf of the owner to document the goals for the project and to continually review the design, construction, and turnover the building to verify that the owner's goals are met.

The responsibilities of the owner, A/E, Commissioning WorCx, and contractors for the various tasks of the commissioning process are detailed in the following table.

Table 2: Commissioning Responsibilities

Cx TASK	Provided By				Provided To				Planning Phase	Design Phase	Construction Phase	Turnover Phase	Operation Phase
	Owner	A/E	CxA	Contractors	Owner	A/E	CxA	Contractors					
Owners Project Requirements			X		X	X		X		Draft OPR narrative, revised OPR narrative	Updated OPR narrative	Updated OPR narrative	Updated OPR narrative
	X	X		X			X			Review comments on draft OPR narrative	Review comments	Review comments	Review comments
Basis of Design			X			X			Basis of design requirements and/or template				
		X					X		Preliminary basis of design, final basis of design	Updates to basis of design	Updates to basis of design	Updates to basis of design	Updates to basis of design
			X		X	X		X	Review comments	Review comments	Review comments	Review comments	Review comments
Commissioning Plan			X		X	X		X	Initial draft of Cx Plan	Periodic updates of Cx Plan	Periodic updates of Cx Plan	Periodic updates of Cx Plan	
	X	X		X			X		Comments	Comments	Comments	Comments	
Specifications			X			X			Specification sections with Cx requirements				
		X			X		X		40% specifications	70%, 99%, and CD specifications	Addendums		
			X		X	X			Suggested revisions/CxA's requirements	Review comments	Review comments		

Cx TASK	Provided By				Provided To				Planning Phase	Design Phase	Construction Phase	Turnover Phase	Operation Phase
	Owner	A/E	CxA	Contractors	Owner	A/E	CxA	Contractors					
Drawings		X			X		X		40% drawings	70%, 99%, and CD drawings	Addendums and supplemental drawings		
	X		X				X		Review comments	Review comments	Review comments		
Pre-construction meeting			X		X						Date, time, and location of meeting		
			X			X		X			Presentation on project, answer questions		
Submittals / shop drawing review				X		X	X				Copies of submittals and shop drawings		
			X		X	X					CxA's submittal review comments		
		X			X		X	X			CxA and A/E's integrated submittal review comments		

Change orders, requests for information		**X**		**X**			**X**				**Copies if pertain to commissioned systems**	**Copies if pertained to commissioned systems**	
			X		**X**	**X**					**Comments**	**Comments**	
			X		**X**	**X**					**A/E action**	**A/E action**	
Commissioning Process Issues			**X**		**X**			**X**		**Weekly unresolved issues report**	**Weekly unresolved issues report**	**Weekly unresolved issues report**	**Final issues summary report, including resolved and unresolved items.**
				X			**X**			**Actions taken for issue**	**Actions taken for issues**	**Actions taken for issues**	**Summary of resolution plan for remaining issues**
Construction checklists			**X**		**X**	**X**		**X**			**Sample checklists sent out by CxA for review**		
	X	**X**		**X**			**X**				**Develop review comments on sample checklists**		
			X					**X**			**Final copies of checklists produced, set up tracking database**		

Cx TASK	**Provided By**				**Provided To**				**Planning Phase**	**Design Phase**	**Construction Phase**	**Turnover Phase**	**Operation Phase**
	Owner	**A/E**	**CxA**	**Contractors**	**Owner**	**A/E**	**CxA**	**Contractors**					
Construction checklists (continued)				**X**	**X**		**X**				**Fill out checklists as equipment is installed, when complete, and provide weekly copy of database to CxA.**	**Completed checklists returned to owner at end of project.**	
Checklist tracking reports				**X**	**X**	**X**	**X**				**Weekly checklist tracking reports**		
			X					**X**			**Completion of checklists is acceptable / unacceptable**		
	X							**X**			**Project ahead / on / behind schedule**		
Site visits			**X**		**X**	**X**		**X**			**Notification of meetings, site visit reports & meeting minutes**	**Notification of meetings, site visit reports & meeting minutes**	
	X	**X**		**X**			**X**				**Attend meeting, status of outstanding issues**	**Attend meeting, status of outstanding issues**	

O&M manual				**X**	**X**	**X**	**X**				**Preliminary copy of O&M manual**	**Final copy of O&M manual**	
	X	**X**	**X**					**X**			**Review comments**	**Review comments**	
Testing , adjusting, and balancing				**X**	**X**	**X**	**X**				**TAB plan**	**TAB report**	
	X	**X**	**X**					**X**			**Review comments**	**Review comments**	
				X			**X**					**TAB technician to verify up to 10% of measurements**	
			X		**X**	**X**		**X**				**Report on TAB verification**	
Training			**X**		**X**			**X**			**Training forms**	**Review comments on training agenda materials, session evaluation**	

Cx TASK	**Provided By**				**Provided To**				**Planning Phase**	**Design Phase**	**Construction Phase**	**Turnover Phase**	**Operation Phase**
	Owner	**A/E**	**CxA**	**Contractors**	**Owner**	**A/E**	**CxA**	**Contractors**					
Training (continued)				**X**	**X**		**X**				**Completed training forms, training agenda and materials**	**Videotape of training sessions**	
Functional performance testing			**X**		**X**			**X**			**Functional performance testing procedures**	**Functional performance testing report**	**Update report to include seasonal dependent functional performance testing results**
	X			**X**			**X**				**Review comments**	**Attend functional performance testing, review report**	**Attend seasonal dependent functional performance testing, review report**
Record drawings				**X**	**X**	**X**	**X**				**Periodic updates of record drawings**	**Final record drawings, corrections to final drawings**	
		X	**X**		**X**			**X**			**Review comments**	**Review comments**	
Cx report			**X**		**X**	**X**		**X**				**Preliminary report**	**Final report (after lessons learned workshop)**
	X	**X**		**X**			**X**					**Review comments**	**Review Comments**
Warranty review	**X**						**X**						**Report problems encountered during operation meeting and walk-through**

			X		X								**Meeting and walk-through, recommendations on system improvements / fixes**
	X							X					**Direction to make repairs / changes**
Lessons Learned Workshop			X		X	X		X					**Date, time, location of workshop, summary of results of workshop**
	X	X		X			X						**Attend meeting, provide input**

*** Parties aren't present during all of the phases listed.**

Communication Structures

Clear and concise communication structures are needed for this project to ensure consistent and efficient information flow. These communication structures have been developed by Commissioning WorCx based upon the specifications for the project, and include RFI's, change orders, project schedules, submittals, training (materials, agenda, etc.) and commissioning process issues.

Some general notes on communication:

- Commissioning WorCx cannot direct the contractors in any of their work.
- All communication between Commissioning WorCx and sub-contractors will be through the general contractor. In cases where correspondence is sent to a sub-contractor, the general contractor will be copied.
- The owner will be copied on all direct communication from Commissioning WorCx to the contractors or the architect/engineer.
- The owner, A/E, and contractors should provide responses to Commissioning WorCx's review comments and proposed checklists and procedures in a timely manner.
- The CxA should incorporate comments on proposed checklists and procedures in a timely manner.
- Whenever possible, communication from Commissioning WorCx will be done electronically via email.

The communication structures for this project are shown below.

Figure 3: RFI Communication Structure

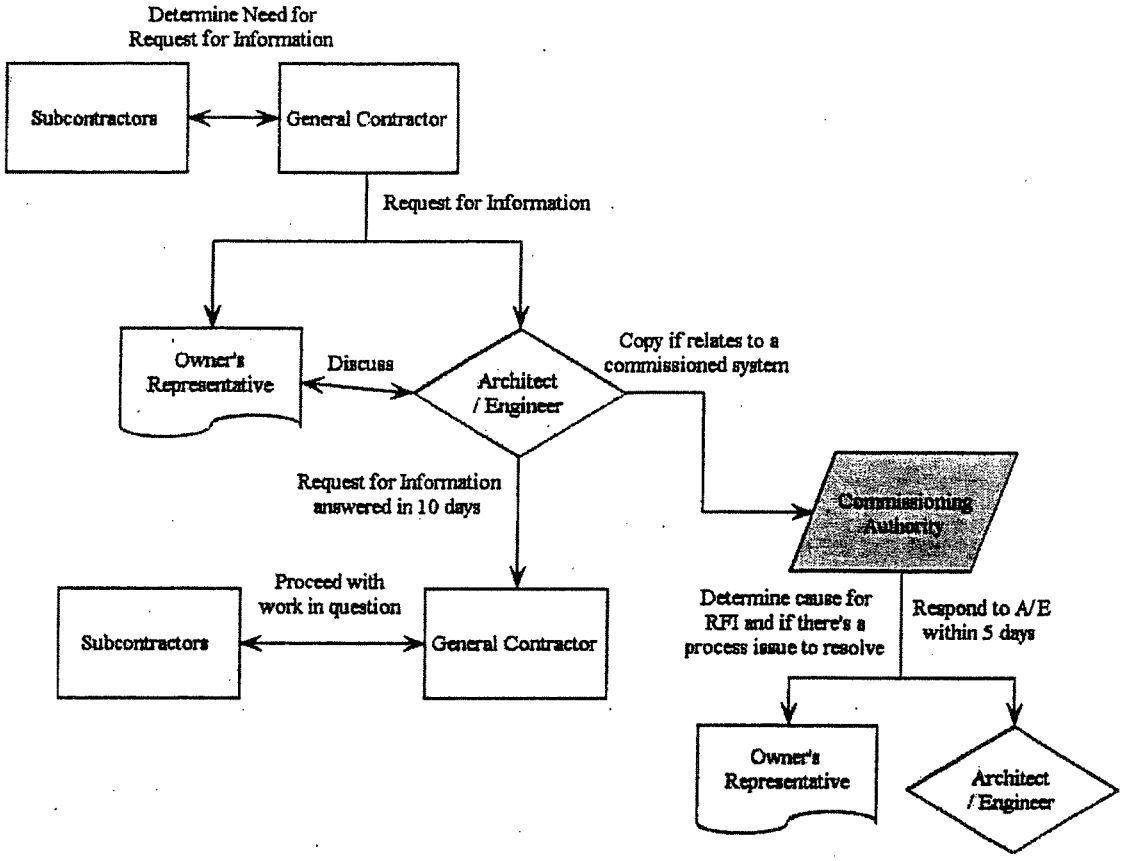


Figure 4: Change Order Communication Structure

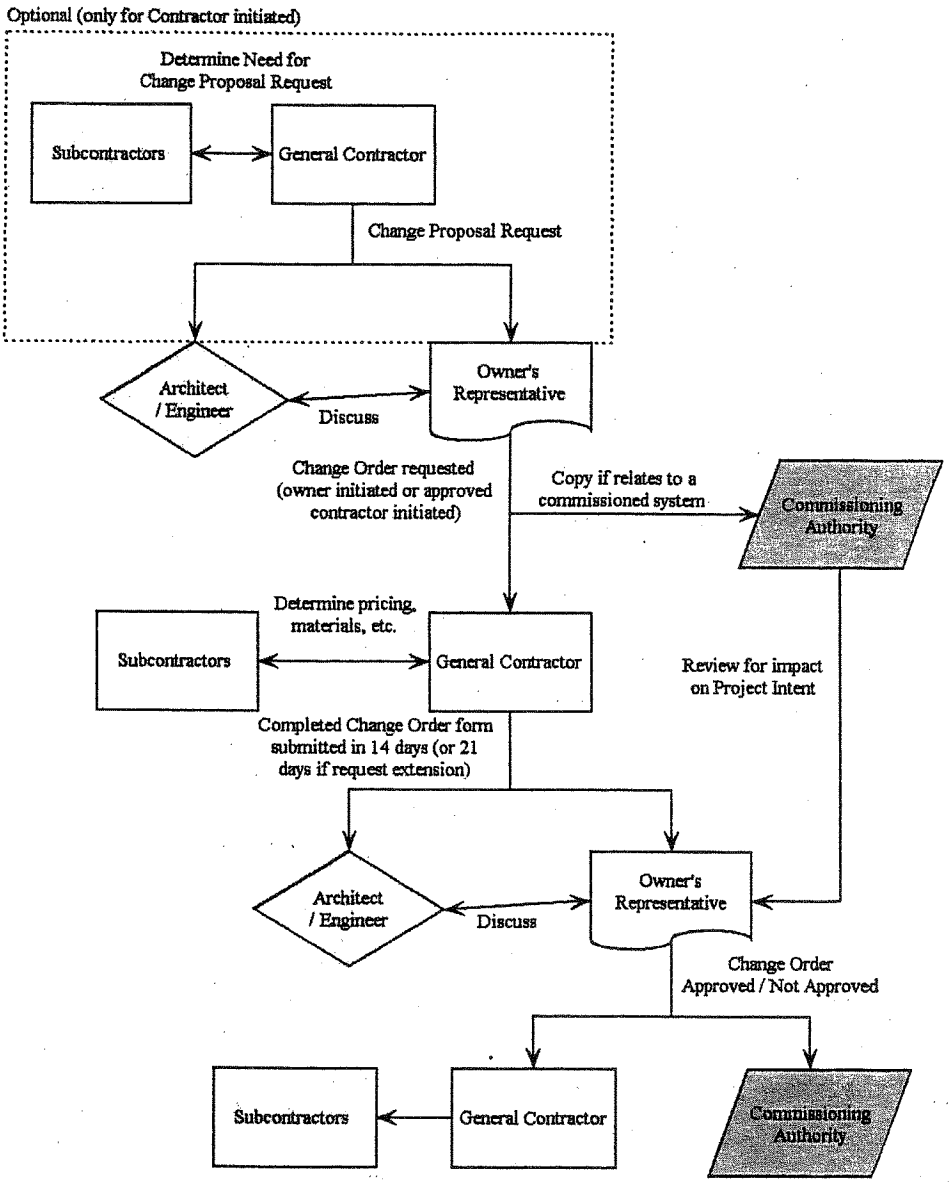


Figure 5: Project Schedule Communication Structure

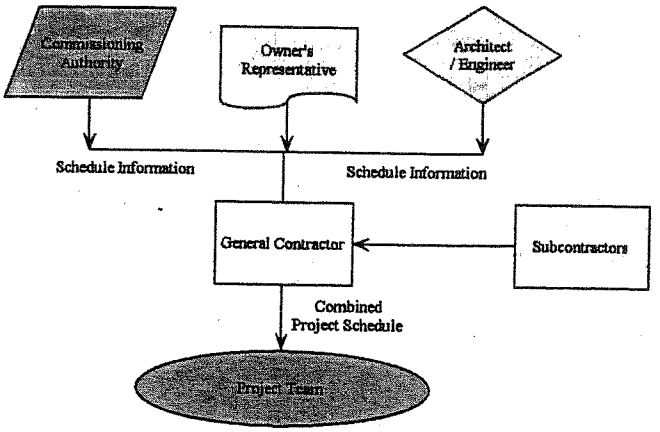


Figure 6: Submittal Communication Structure

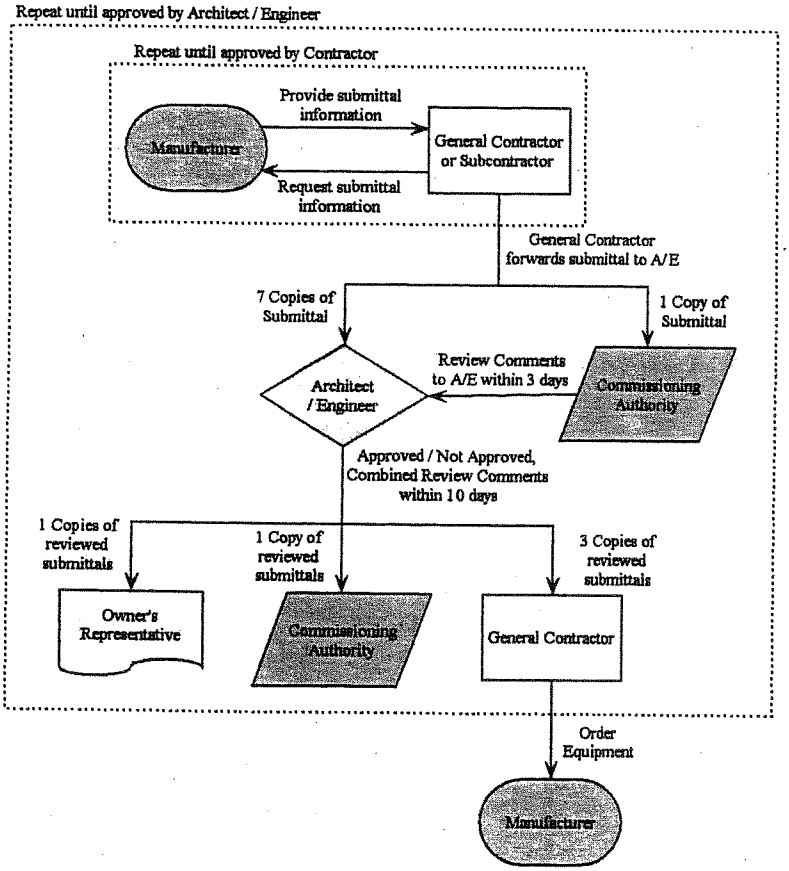


Figure 7: Training Communication Structure

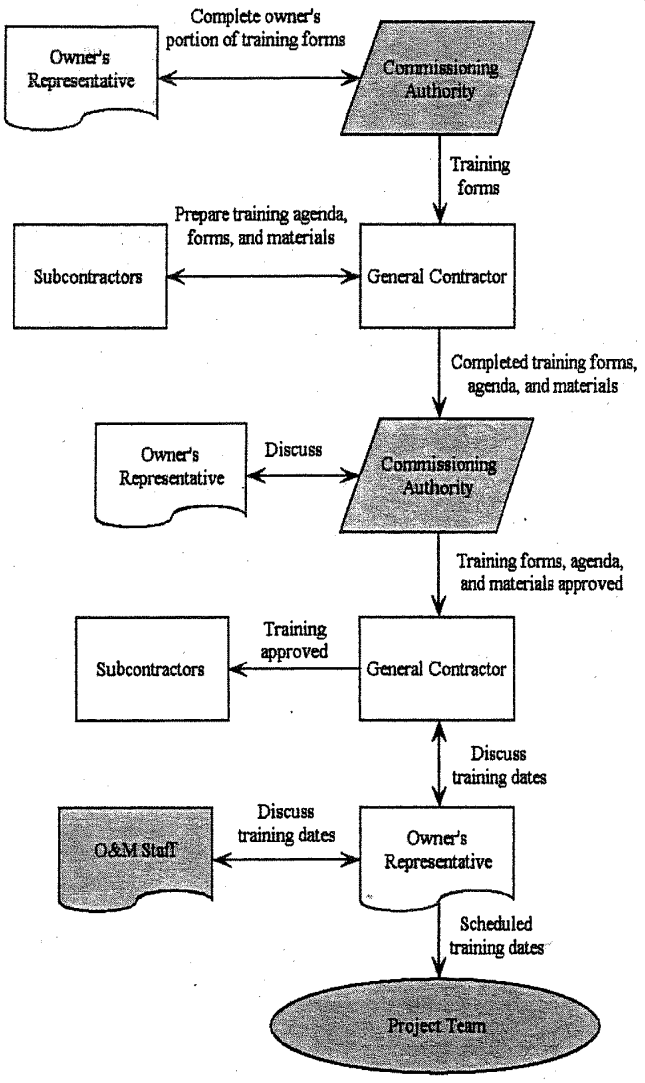
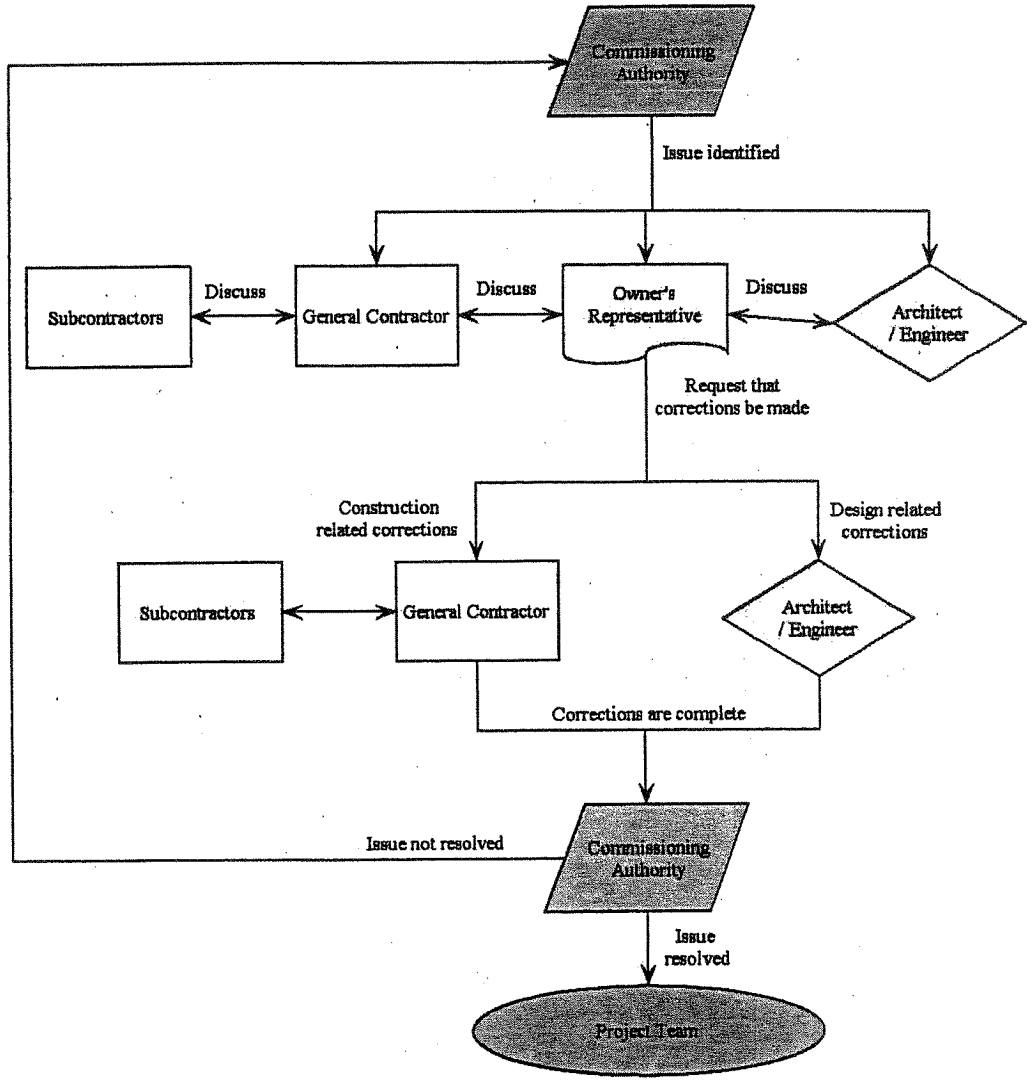


Figure 8: Commissioning Process Issue Communication Structure



UNC Chapel Hill Bingham Hall Renovation
Project Directory

Table 3: Contact Information
The contact information for the commissioning team members is listed in the table below.

Role	Company Name	Contact Person	Address/E-Mail	Phone	Cell Phone	Fax
Owner	UNC Chapel Hill	Rabold, Rod Senior Commissioning Engineer UNC-CH Engineering Services	rod.rabold@facilities.unc.edu	(919) 883-7405		
		Quade Gallagher PM, Planning &Project Management Facilities Planning and Design	quadeg@unc.edu	(984) 484-4113		
		Todd Freeman	Todd.Freeman@facilities.unc.edu			
		Anthony Beale	anthony.beale@facilities.unc.edu			
Owners Rep						

Role	Company Name	Contact Person	Address/E-Mail	Phone	Cell Phone	Fax
GC	Newcomb & Boyd	Reade Daniel	DDaniel@newcomb-boyd.com	919.783.8973		
Cx Agent	Commissioning WorCx	Tom Foster, Founder	4915 Piedmont Parkway, Suite 105 Jamestown, NC 27282 tfoster@commworcx.us		336.601.2249	
		Lee Huffines, Managing Partner	lhuffines@commworcx.us		336.501.2164	
		John Griffin, TAB Engineer/ Site Supervisor	jgriffin@commworcx.us		910-308-7379	
		Matthew Ritter Commissioning Tech	mritter@commworcx.us		336-340-4235	
		Kevin Phillips Commissioning Tech	kphillips@commworcx.us		740-439-7298	
		Taryn Wooten, Document Manager	twooten@commworcx.us		336-419-6392	
Architect	Lord Aeck Sargent					
Mechanical Engineer						
Plumbing Engineer						
Electrical Engineer						
Sub-Contractors						

Role	Company Name	Contact Person	Address/E-Mail	Phone	Cell Phone	Fax
Mechanical Contractor						
Plumbing Contractor						
Electrical Contractor						
TAB Contractor						
Controls Contractor						

Commissioned Systems and Equipment

Table 4: Commissioned Systems and Equipment*

*See CxAlloy

SECTION 02 03 42 - REMOVAL AND SALVAGE OF PERIOD CONSTRUCTION MATERIALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work includes deconstruction and salvage of identified historic items and materials and removal of rubbish and debris.

B. Specified procedures required for preservation, rehabilitation, restoration, and reconstruction treatment areas.

C. Historic items and materials are indicated on drawings.

1.02 RELATED REQUIREMENTS

A. Section 02 41 00 - Demolition: Selective demolition of nonhistoric building elements for alteration purposes.

1.03 DEFINITIONS

A. Debris: Nonhistoric building materials and contents destroyed during demolition.

B. Deconstruction: Systematic dismantling and removal of a structure or its parts and salvage of elements and components for reuse, recycling, and retaining maximum value.

1.04 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.05 SUBMITTALS

A. Deconstruction Crew's Qualification Statement: Documentation of three consecutive years of work of this type, including similar projects identifying when, where, and for whom the work was performed.

B. Work Plan: Detailed, proposed instructions for each type of operation of procedures for accomplishment of deconstruction work, including detailed description of the methods and equipment to be used and sequence of operations. Include the following:

1. Extent of deconstruction, removal sequences, temporary and permanent bracing and shoring, and location and construction of barricades and fences.
2. Instructions for removal and disposition of period materials specified to be salvaged or recycled.
3. Dust control measures.
4. Protection of property to remain undisturbed.
5. Ensure coordination with other work.
6. Plan for sequencing and timely disconnection and reconnection of utility and facility services.
7. Safe conduct of the work. Submit for information only.

1.06 QUALITY ASSURANCE

A. Deconstruction Crew Qualifications: Workers trained and experienced in removal and salvage of historic materials.

1.07 FIELD CONDITIONS

A. Dust Control: Control dust resulting from removal, salvage, and demolition operations from spreading to occupied portions of the project and creating a nuisance in surrounding area. Use of water to control dust is not permitted when it will result in or create:

B. Protection of Existing Historic Property: Before beginning removal, salvage, or demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Take necessary precautions to avoid damage to existing items to remain in place, be reused, or remain Owner's property. Repair or restore to original condition items damaged by Contractor, using approved means, methods, and techniques. Replace items that cannot be successfully repaired or restored to original condition.

1. Construct and maintain shoring, bracing, and supports required as a result of cutting, removal, or demolition work
2. Ensure that structural elements are not overloaded.

C. Store materials to be salvaged or recycled daily, out of contact with the ground, under weathertight covering, in areas designated by Owner, and in the manner direct by Owner.

D. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL PROCEDURES

A. Drawings indicating existing construction, building services, and site utilities are based on casual field observation and existing record documents only.
1. Report discrepancies to Architect before disturbing existing historic elements.
2. Beginning of work constitutes acceptance of existing conditions that are apparent upon examination at that time.

B. Separate spaces in which removals and salvage operations are conducted from occupied spaces.
1. Provide, erect, and maintain temporary dustproof partitions; see Section 01 50 00.

3.02 ENVIRONMENTAL CONTROLS

A. Comply with federal, state, and local regulations pertaining to water, air, solid waste, recycling, chemical waste, sanitary waste, sediment, and noise pollution.

3.03 ITEMS TO BE SALVAGED

A. General: Salvage elements and components to the maximum extent possible. Maintain a chain of custody of salvaged materials, including the condition of such materials before and after salvage operations.

B. Masonry Elements: Remove intact and salvage brick.

C. Metal Elements: Remove intact and salvage metal elements indicated on drawings.

D. Wood Elements: Remove intact and salvage wood elements indicated on drawings and wood plank office flooring.

E. Thermal and Moisture Protection Elements: Remove intact and salvage roof tiles.

F. Windows: Remove intact and salvage windows indicated on drawings..

G. Finishes: Protect special or historic finishes and finish elements indicated on drawings.

3.04 MATERIALS TO BE REMOVED

A. Remove existing nonhistoric elements as indicated and as required to allow direct access to period construction elements indicated to be restored or salvaged for reuse.
1. Remove items indicated on drawings.

B. Protect existing historic elements.
1. Prevent movement of structure; provide temporary, removable shoring and bracing if necessary.
2. Perform cutting to accomplish removals neatly, minimizing overcutting.

3.05 MATERIALS TO BE RECYCLED

A. Recycle removed nonhistoric materials to the maximum extent possible. Remove recyclable materials by hand wherever possible.

B. Recycle items indicated on drawings.

3.06 CLEANING

A. Upon completion of work, clean dust, dirt, and debris caused by salvage and demolition operations from portions of existing structure to remain and adjacent areas. Remove and transport debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Obey local regulations regarding hauling and disposal.

END OF SECTION

SECTION 02 41 00 - DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of building elements for alteration purposes.

1.02 DEFINITIONS

A. Demolition: Dismantle, raze, destroy or wreck any building or structure or any part thereof.

B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.

C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.

D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.

E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

PART 3 EXECUTION

2.01 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Provide, erect, and maintain temporary barriers and security devices.
   3. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   4. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
   5. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements to remain in place and not removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

D. Hazardous Materials:
   1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.

E. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Dismantle existing construction and separate materials.
   2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

2.02 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
   1. Verify construction and utility arrangements are as indicated.
   2. Report discrepancies to Architect before disturbing existing installation.

3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Remove existing work as indicated and required to accomplish new work.
   1. Remove items indicated on drawings.

C. Protect existing work to remain.
   1. Prevent movement of structure. Provide shoring and bracing as required.
   2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch to match new work.

2.03 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 02 80 10–REMEDIATION GENERAL REQUIREMENTS

1.0 DEFINED SCOPE OF WORK

Description of the Project: The information provided is based on the best information available at the time of specification preparation. Nothing in this section may be interpreted as limiting the scope of work otherwise required by this contract and related documents. Quantities are estimates, placing full verification by the Contractor before bidding the project.

The subject property includes a four-story structure comprised of a basement, first, second, and third floors. The 31,000 square foot building was constructed in 1927. The project is intended to address significant deferred maintenance throughout the facility including building envelope, architectural finishes, building systems, life safety, accessibility, and abatement as well as explore opportunities for programmatic upgrades.

The project includes the removal of friable and nonfriable asbestos containing and contaminated materials (along with all labor, disposal and work practices required) for the UNC – Bingham Hall located at 201 Lenoir Drive in Chapel Hill, North Carolina. The contract includes the removal of non-PCB ballasts and fluorescent light tubes scheduled to be replaced as part of the lighting upgrade.

As with renovations, there may be unknown conditions, but these conditions do not limit the responsibility of the contractor to complete the contract. This project includes the remediation and disposal of all environmental waste containing materials and/or contaminated materials in the following approximate quantities and descriptions, along with the demolition, and other site work as specified.

The list of asbestos containing materials (ACMs) identified in Bingham Hall includes the materials identified in the assessment performed by S&ME on February 23 and March 3, 2022. The materials listed below will be impacted by the Renovation.

Table I
Asbestos Containing Materials
UNC Bingham Hall

HA	Material Description	[a]Location	[b]Quantity (Approx.)	[c]Type	[d]Cond / PD	Percent & Type Asbestos
T	Corrugated Paper Type Thermal System Insulation; 8” Diameter	Running North to South in Crawlspace	310 LF	TSI	Poor/ High	65% Chrysotile
U	Hard elbow associated with HA T	Crawlspace	60 Fittings	TSI	Poor/ High	70% Chrysotile
Y	Window Caulk	Exterior side of windows	195 Windows	Misc.	Poor/ High	2% Chrysotile
Z	Window Glazing	Exterior east side of the building-1st floor window	**1 each	Misc.	Poor/High	2% Chrysotile
N/A	TSI Contaminated	Crawlspace	3,500 SF	TSI	Poor/ High	Assumed

HA	Material Description	[a]Location	[b]Quantity (Approx.)	[c]Type	[d]Cond / PD	Percent & Type Asbestos
	Soil (Depths of Contamination Vary) including all debris within the crawlspace					
T and U	Hidden Pipe and Fitting Insulation	Potentially concealed in wall cavities	1,000 LF Allowance	TSI		65-70% Chrysotile
	Asbestos Wiring	Attic, connected to Dry Cell "D" Batteries	<10 LF	TSI	Fair/ High	Presumed
	Mirror Mastic	Behind mirrors in Bathrooms	15 Mirrors	Misc.	Good/ High	Presumed

HA = Homogeneous Area SF = Square feet LF = Linear feet CF = Cubic Feet
[1]Refer to Appendix 2 for specific sample locations.
[2]Quantities are approximate and should not be used for cost estimates or bidding purposes.
[3]Type: Misc. = Miscellaneous Sur = Surfacing TSI = Thermal System Insulation
[4]Cond = Condition: Good, Fair or Poor PD = Accessible during renovation or demolition, Potential for Disturbance; Low/High
**More windows with the asbestos glazing may be present

Note: Quantities are estimates and should not be used for cost estimates or bidding purposes.

Asbestos containing window caulking, window glazing and mirror mastic shall be removed using nonfriable removal techniques. Non-friable removal techniques will include hand scraping and electric heat guns when needed to loosen the caulking and/or mastic. Open flame equipment such as torches will not be permitted.

Friable materials such as pipe insulation, potentially contaminated debris, and contaminated soil in the crawlspace shall be removed using OSHA Class I removal procedures including Type C respiratory protection. Pipe and fitting insulation shall be removed utilizing friable removal techniques such as the glovebag method.

As with any renovation, there may be additional environmental contaminants found during the demolition process of the building. If an environmental contaminant is identified as a different type of material than what was previously identified, it must be assumed positive or tested.

A brief description of the asbestos-containing and/or asbestos-contaminated materials to be abated can be found in Attachment I - Inspection Report. This data is provided for informational purposes and is based on the best information available at the time of specification preparation. Contractor is responsible for verification of the materials present and the abatement of the ACMS scheduled to be impacted by the renovation. Nothing in this section may be interpreted as limiting the scope of work otherwise required by this contract and/or related documents.

2.0 OTHER HAZDARDOUS MATERIALS

Light tubes and non-PCB ballasts will require proper disposal as universal waste. The remediation firm will collect and discard the light tubes and ballasts.

A. POLYCHORINDATED BIPHENYLS (PCB BALLASTS)
Light ballasts manufactured through 1979 can contain PCBs. Ballasts manufactured after 1979 that do not contain PCBs and are labeled “No PCBs”. If a light ballast is not labeled “No PCBs,” it must be assumed to contain PCBs. The contractor shall safely remove ballasts and observe the written information on the ballast. Ballasts that contain PCBs shall be placed into a UN approved 55-gallon drum for disposal and shall be shipped on a Hazardous Waste Manifest. The lid on the drum shall be secured unless the contractor is actively placing ballasts into the drum. A Class 9 label should be placed on the drum as soon as the first ballast is placed into it. The contractor will consider a ballast as containing PCBs if the written information of the ballast indicates it contains PCBs or does not clearly indicate it does not contain PCBs. S&ME assessed the light fixtures and suspects no PCB ballasts are present in Bingham due to a previous lighting upgrade project.

Non-PCB ballasts will have “No PCB’s” written on them. The contractor shall place non-PCB ballasts in a different UN-approved 55-gallon drum. Only non-PCB ballasts shall be placed in the drum. The lid on the drum shall be secured unless the contractor is actively placing ballasts into the drum. The drum should be labeled as soon as the first ballast is added.

B. FLOURESCENT LIGHT TUBES AND COMPACT FLOURESCENT LAMPS

The contractor shall remove and handle fluorescent tubes, high intensity discharge bulbs and U-Tubes in a manner which will minimize occurrences of lamp breakage. Unbroken bulbs are much easier and safer to manage than broken bulbs. The lamps shall be placed in the manufacturers’ box or other suitable containers (sturdy cardboard box with cushioning material) appropriate for shipment to the recycling facility. When not actively putting bulbs into the box, the contractor shall close and seal the box. Boxes shall be stored in a dry location and shall remain dry. A Universal Waste label shall be placed on each box as soon as one bulb is placed into the box. If a bulb does break it shall be handled as hazardous waste and the materials should be properly contained in a UN polyethylene drum and disposed of properly, and in a timely manner. The container must be capped with a lid that ensures no material will be spilled from the container during storage or transport and labeled appropriately, including a class 8 corrosive sticker. The boxes cannot be stored outside due to weather conditions and potential breakage of the bulbs. The date shall be marked on each container to document the generation date.

C. LEAD-CONTAINING PAINT AND LEAD-BASED PAINT

A limited lead sampling was conducted during our asbestos inspection and previous testing by UNC. The list of lead containing paint (LCP) identified in Bingham Hall includes the materials identified in the assessment performed by S&ME. The materials listed below will be impacted by the Renovation.

Table II
Lead Containing Paint
UNC Bingham Hall

Sample Number	Substrate	Component	Color	Sample Location	Concentration (% by weight)
Pb-01	Metal	Radiator	Crème	Rooms	0.60
Pb-02	Metal	Interior Window Casing	Cream	Rooms	0.66
Pb-03	Metal	Exterior Window Frame	Tan	Exterior	13.0

Lead-containing paint and lead-based paint were identified. The contractor shall assume lead-containing paint is present due to the 1927 date of construction. The contractor is responsible for OSHA compliance with 29 CFR 1926.62-OSHA Lead Construction Standard. This is strictly an OSHA concern for the Contractor and should not impact the price for abatement. In addition, the contractor is responsible for any requirement of the Toxicity Characteristic Leaching Procedure (TCLP) sampling for disposal purposes.

The tan paint on the exterior and the white paint on the interior windows shall be removed in accordance with OSHA 29 CFR 1926.62. The contractor shall designate an area to perform the paint stabilization of the window frames. Demarcate the area with barrier tape and signage which indicates lead hazards. Utilizing manual methods, remove the residual paint from the frames. Once the paint is removed, utilize disposable wipes to clean the frame, only utilizing the wipe to conduct one pass over the frame and discard as lead-contaminated debris. Any liquid waste generated during the removal of the paint, including the paint chips shall be discarded as hazardous waste. A TCLP sample shall be collected by the Contractor, and the results must be reported to Mr. Mike Long with EHS, 919-962-5509, mdlong@unc.edu prior to disposal. S&ME's onsite IH shall conduct a visual inspection and collect lead wipe samples once the caulking and lead paint are removed from the window frames. If the contractor prefers to refurbish the window frames remotely, the Project Designer and UNC's EHS Department must provide approval.

The lead paint on the radiators is chipping and flaking. If the radiators are scheduled to be removed, discard as construction debris. If the radiators are scheduled to remain in place. Perform paint stabilization and manage the process identical to the refurbishment of the windows.

D. DRYCELL "D" BATTERIES

Drycell "D" batteries were identified in the attic with asbestos insulated wiring. Remove the wiring and discard as ACM waste. Remove the batteries and discard as universal waste per UNC-EHS requirements.

E. MOLD

Visible mold was identified on the structural steel beams in the attic. Cleaning the metal beams with an EPA approved antimicrobial agent will be required. A Safety Data Sheet (SDS) for the antimicrobial agent shall be submitted to the Project Designer for approval prior use. Once the beams are cleaned, the onsite IH will perform a visual inspection and collect random swabs to verify the cleanliness of the beams.

3.0 DISCREPANCIES OR INCONSISTENCIES IN ESTIMATES:

A. The quantities and location of environmental contaminants identified in this section and the extent of work included in this section are primary estimates based on the information available at the time of this specification preparation, or which were limited by the physical constraints of the building. Accordingly, if there are additional quantities of environmental waste to be removed (above the provided estimate of materials) the contractor will be held fully responsible for remediation of these materials at no additional cost to the owner or others. The contractor is held responsible for PRE-BID PHYSICAL VERIFICATION of amounts of environmental contaminants to be removed.

END OF SECTION

SECTION 02 80 20 - REMEDIATION COORDINATION

1.0 GENERAL

A. All environmental contractors will be licensed general contractors in either the specialty interior, building, unclassified or asbestos categories by the North Carolina Licensing Board of General Contractors and limited for the bid amount.

B. The contractor shall be responsible for inspecting the site(s) prior to bidding/work to confirm the scope of work. Any quantities listed by the designer in the plans, specifications, or inspection are done so as approximations. The actual quantities of asbestos containing/contaminated material or other hazardous waste to be encountered are the responsibility of the contractor.

C. The contractor shall furnish and is responsible for all costs including, but not limited to: permit fees, containment preparation, labor, materials, services, insurance, bonding, and equipment necessary to carry out the remediation/demolition operations and disposal of all asbestos containing/contaminated and other hazardous materials in accordance with the plans and specification, waste disposal containers, the EPA, and OSHA regulations, and any applicable state and local government regulations.

D. The contractor/employer has assumed the responsibility of proceeding in such a manner that he offers his employees a workplace free of recognized hazards causing or likely to cause death or serious injury. The contractor shall be responsible for performing this remediation/demolition and disposal so that airborne asbestos or other hazardous materials do not exceed established legal levels.

E. The contractor will be responsible for all costs associated with employee monitoring to meet the OSHA requirements.

F. The contractor is responsible for all costs, including additional visits, should the designer and/or the industrial hygiene firm determine that the contractor failed a final inspection. Notification and scheduling of the final inspection during the project is the responsibility of the contractor. The contractor will allow a minimum notice of 48 hours unless the designer and the contractor agree upon a different period.

2.0 ABATEMENT CONTRACTOR'S PERSONNEL:

A. GENERAL SUPERINTENDENT:

1. Provide a General Superintendent accredited in asbestos work and experienced in administration, environmental remediation, general contracting coordinating, including work practices, protective measures for building and personnel, disposal procedures, etc. This person is responsible for compliance with all applicable federal, state, and local regulations, particularly those relating to asbestos-containing materials as outlined in OSHA 29 CFR 1926.1101 and including 1926.20 through 1926.32. The Superintendent needs to be knowledgeable of the North Carolina Department of Health Hazards Control Unit; NC/DHHS/Division of Public Health North Carolina Administrative Code Chapter 10-A Subchapter 41C-Occupational Health Section .0600-Asbestos Hazard Management Program 10A NCAC 41C.0601, OSHA 29 CFR 1926.1101 Asbestos in Construction, and EPA NESHAP 61.140 Subpart M-National Emission Standard for Asbestos.

2. The General Superintendent shall be trained in HAZWOPER.

3. Submit to the Owner's Representative a request for approval for any person intended to be employed in the project with said employees' name, and qualifications. ("Affidavit of

Medical Surveillance and Respiratory Protection" should be available if requested by the building owner's representative and/or an OSHA Inspection Officer.) The Building Owner's representative and/or IH firm reserves the privilege of approving all General Superintendents and/or Supervisor(s) named for said project. The building owner's representative and/or IH firm also reserves the privilege of requesting that any General Superintendent, Supervisor and/or workers that do not perform in an acceptable professional manner be asked to leave the worksite either on a temporary or permanent basis.

4. Experience and Training: The General Superintendent must be accredited as an Asbestos Abatement Supervisor in accordance with the AHERA regulation 40 CFR Part 763, Subpart E, Appendix C, and as amended February 3, 1994 (ASHARA) and be accredited as a NC-DHHC Supervisor. They must have a minimum of Five (5) years on-the-job training in asbestos abatement procedures and have worked at least eight (8) projects, three (3) of which are comparable in complexity and size to this project.

B. ASBESTOS SUPERVISOR(S):

1. Provide full time NC-DHHS Accredited Supervisor(s) for inside the asbestos work area with experience in asbestos abatement projects including work practices, protective measures for building and personnel, disposal procedures, etc. One inside supervisor must be able to communicate in the language of the workers and be able to communicate in English to the Building Owner's Representative(s) and/or state regulator personnel. All inside supervisor(s) are responsible for compliance with all applicable federal, state, and local regulations, particularly those relating to asbestos-containing materials as outlined in OSHA 29 CFR 1926.1101 and including 1926.20 through 1926.32. The Supervisor(s) need to be knowledgeable of the North Carolina Department of Health Hazards Control Unit; NC/DHHS/Division of Public Health North Carolina Administrative Code Chapter 10-A Subchapter 41C-Occupational Health Section .0600-Asbestos Hazard Management Program 10A NCAC 41C.0601, OSHA 29 CFR 1926 Asbestos in Construction, and EPA NESHAP 61.140 Subpart M-National Emission Standard for Asbestos.

2. Submit to the Owner's Representative a request for approval for any person intended to be employed in the project with said employees' name, social security, qualifications, and ("Affidavit of Medical Surveillance and Respiratory Protection" should be available if requested by the building owner's representative and/or an OSHA Inspection Officer.) The Building owner's representative and/or IH firm reserves the privilege of approving all General Superintendents and/or Supervisor(s) named for said project. The building owner's representative and/or IH firm also reserves the privilege of requesting that any General Superintendent, Supervisor and/or workers that do not perform in an acceptable professional manner be asked to leave the worksite either on a temporary or permanent base.

3. The Site Superintendent/Supervisor and firm shall have Institute of inspection cleaning and Restoration Certification (IICRC), American Council for Accredited Certification (ACAC) or Indoor Air Quality Association (IAQA) Certification for mold remediation.

4. The site Superintendent/Supervisor shall have lead training per the OSHA Lead in Construction Standard 29 CFR 1926.62.

5. Experience and Training: The Asbestos Supervisor(s) (competent person) must be accredited as an Asbestos Abatement Supervisor in accordance with the AHERA regulation 40 CFR Part 763, Subpart E, Appendix C, and as amended February 3, 1994 (ASHARA) and by NC-DHHS. The inside asbestos supervisors must have a minimum of Three (3) years on-the-job training in asbestos abatement procedures and have

worked at least five (5) projects, two (2) of which are comparable in complexity and size to this project.

6. OSHA Requirements:
It is the Remediation Contractor's responsibility to fulfill all the Occupational Safety and Health Administration (OSHA) requirements under Respiratory Protection Standard CFR 1910.134, Hazard Communication Standard 29 CFR 1910.1200, 29 CFR 1926.1101, and all other safety requirements that may be required by the work site.

C. NON-SUPERVISORY PERSONNEL:
1. Provide an adequate number of qualified and accredited personnel to meet the schedule requirements of the project. Submit to the Owner's Representative a request for approval for any person intended to be employed in the project with said employees' name, social security number, qualifications, "Certificate of Workers' Acknowledgment", and "Affidavit of Medical Surveillance and Respiratory Protection".

2. Experience and Training: All workers employed for abatement (friable and nonfriable) throughout the project shall be accredited as an Asbestos Abatement Workers in accordance with the AHERA regulation 40 CFR Part 763, Subpart E, Appendix C and as amended February 3, 1994 (ASHARA) and be accredited as NC-DHHC Asbestos Workers. If contractor plans to use Non-Accredited Personnel to perform any nonfriable work practices the permission of the building owner’s representative must be obtained.

D. ADDITIONAL TRAINING REQUIREMENTS:
1. Any Sub-Contractors that may encounter hazardous materials must be certified to wear personal protective equipment (PPE) and be in compliance with OSHA 29 CFR 1910.134 Respiratory Protection Standard and any other standards on the Z list that may require additional medical surveillance.

2. Abatement Contractor will be responsible for assigning only appropriately trained and accredited General Superintendents, Supervisor(s) and/or non-supervisory (worker level) personnel to a specific environmental and/or work task.

3. A small quantity handler of universal waste must inform all employees who handle or have responsibility for managing universal waste of the proper handling and emergency procedures appropriate to the type(s) of universal waste handled at the facility.

4. The Abatement Contractor, Site Superintendent, Supervisor(s) and Workers shall receive the OSHA 29 CFR 1926.62 Lead in Construction Standard Training. Documentation of their training will be required prior to performing any asbestos remediation of the windows, radiators or other lead painted building components.

3.0 CONTROLLED MATERIALS
A. Controlled Materials are defined as any material that poses a human health threat or can cause damage to the environment. Disposal options are to be thoroughly investigated for Controlled Materials and may involve recycling, reuse, or disposal as solid waste in a regulated municipal landfill. Discharges to the environment and/or improper handling of waste may cause safety issues to Abatement Contractors’ personnel, onsite personnel, innocent bystanders, and/or visitors to the jobsite. The mishandling of materials may lead to liability or penalties to the Building Owner and/or the Abatement Contractor.

4.0 OTHER HAZARDOUS MATERIALS
A. All Abatement Contractors will be informed of known hazards in the worksite in areas where the Abatement Contractor’s employees will be working.

B. Hazardous wastes can be specifically regulated under Resource Conservation and Recovery Act (RCRA) through a number of different regulations, including:

1. Hazardous Waste Identification Regulations (40 CFR Part 261): Classification of solid wastes as hazardous wastes is based on exhibited hazardous waste characteristics and/or on inclusion of the waste on a list of hazardous waste developed by EPA. Once a waste has been identified as hazardous, it must comply with all applicable Federal regulations regarding its management.

2. Universal Waste Regulations (40 CFR Part 273): Streamlined collection requirements for certain wastes including batteries, lamps, and pesticides shall be followed. Discarded mercury-containing equipment was added to the federal list of universal wastes in August 2005.

3. Land Disposal Restrictions (LDR) Regulations (40 CFR Part 268): Regulations to minimize hazards from the land disposal of hazardous wastes by setting treatment standards for mercury in hazardous wastes that must be achieved before land disposal. Other LDR-related regulations that may be of interest include the national treatment variance for radioactively contaminated batteries and standards for contaminated debris and soil.

5.0 NUMBER OF REQUIRED PERSONNEL ON THE PROJECT:

A. The Abatement Contractor will be required to provide a minimum of 2 supervisors with one being the designated General Superintendent. The ratio for supervisors must be maintained at no more than 15 workers to 2 supervisors (excluding the General Superintendent).

7.0 ABATEMENT COMPLETION MEETING

A. At the close of the environmental remediation project and upon final air clearance testing the Owner or the Owner's Representative will meet with the Abatement Contractor's General Superintendent at the project site and complete a final inspection to deem the work area clean or provide a punch list that will deem the project completed per this specification.

8.0 ABATEMENT CONTRACTOR’S SUPERINTENDENT DAILY LOG:

A. Maintain within the on-site job office a daily log documenting the dates and times at a minimum the following items:
   1. Meetings; purpose, attendees, brief discussion
   2. Visitations; authorized and unauthorized
   3. Personnel, by name, entering and leaving the work area
   4. Special or unusual events, i.e. barrier breaching, equipment failures, accidents
   5. Documentation of supervisor and/or workers accreditations, accreditations, and fit tests.
   6. Air monitoring tests and test results
   7. Safety meetings
   8. Personal Safety Monitor for the Day
   9. Record who was responsible for the locking and unlocking of the work area within the building
   10. Amount of material that was removed and/or handled

B. Documentation of Abatement Contractor's performing the following:
   1. Inspection and smoke check of work area preparation prior to start of each shift
   2. Installation and Removal of any sheet plastic critical barriers

3. Abatement Contractor's inspections prior to lock down, final visual request, spray back, fire stop placement or any other operation that will conceal the condition of asbestos-containing materials or the substrate from which such materials have been removed
4. Recording of manometer readings
5. Removal of waste materials from work area
6. Decontamination of equipment (list items)
7. Abatement Contractor's final inspection and request for final air test analysis.

C. Provide two (2) copies of this log to Project Administrator at the final closeout of this project as a project closeout submittal. Have log available for the Building Owner, Owner's Representative, and/or a Regulatory Inspector for review during the project.

9.0 SPECIAL REPORTS:

A. Except as otherwise indicated, submit special reports directly to Owner within one day of occurrence requiring special report, with copy to Owner's Representative and others affected by occurrence.

1. Reporting Unusual Events: When an event of unusual and significant nature occurs at site (examples: failure of pressure differential system, rupture of temporary enclosures), prepare and submit a special report listing chain of events, persons participating, response by Environmental Contractor's personnel, evaluation of results or effects, and similar pertinent information. When such events are known or predictable in advance, advise Owner in advance at earliest possible date.

2. Reporting Accidents: Prepare and submit reports of significant accidents, at site and anywhere else that work is in progress. Record and document data and actions; comply with industry standards. For this purpose, a significant accident is defined to include events where personal injury is sustained, property loss of substance is sustained, or where the event posed a significant threat of loss or personal injury or where there is a contaminant released into the environment.

3. Report Discovered Conditions: When an unusual condition of the building is discovered during the work (e.g. leaks, termites, corrosion) prepare and submit a special report indicating condition discovered.

10.0 JOB SPECIFIC PLAN

A. Prepare and deliver to the Building Owner and/or Building Owner's a Job Specific Plan within 5 calendar days prior to the first preconstruction meeting. *This Job Specific Plan should identify the layout of specific decontamination and work area isolations areas. The plan shall also include a discussion of the non-PCB Ballast removal and disposal process and the disposal process for the light tubes. The time schedule for each phase of work, number of workers, supervisors, subcontractors' timeframes, phasing of the demolition, installation of the fencing, placement of dumpster and type of dumpsters, etc.*

B. Schedule: Provide proposed detailed schedule including work dates, work shift time, number of employees, dates of start and completion dates of each phase of work, including preparation work, removal, demolition, and final inspection dates. Include in the schedule any holidays that the Abatement Contractor expects to work. Building Owner or Building Owner's Representative will give approval on all scheduling.

C. Work Stages: Indicate important stages of remediation and/or construction for each major portion of the work, including clearance testing. Include indication of start and finish times for the following:

1. Submittal of all contractual paperwork
2. Delivery and set up of dumpster
3. Delivery and set up of fencing
4. Set up of and/or loading of equipment onsite
5. Complete any utility cut-offs and/or connections that is necessary prior to the beginning of the project
6. Preparation for the Environmental work
7. Environmental Remediation
8. Clearance testing
9. Demolition, if applicable
10. Substantial Completion

D. This plan should include safety issues for the protection of workers, occupied areas of the building, and/or pedestrians.

E. Include in the Job Specific Plan site-specific emergencies response that include fire, accident, power failure, pressure differential system failure, or any other event that may require modification, abridgment of decontamination, or work area isolation procedures. Note that nothing in this specification should impede safe exiting or providing of adequate medical attention in the event of an emergency.

F. Post: In clean room of Personnel Decontamination Unit and in the General Superintendent Office the telephone numbers and locations of emergency services including but not limited to fire, ambulance, doctor, hospital, police, power company, telephone company (in all appropriate languages).

11.0 PRE-CONSTRUCTION INSPECTION AND PREPARATION:

A. Before any work begins on the remediation and/or dust containment barriers, the Abatement Contractor shall:
   1. Abatement Contractor is responsible for confirmation of utility disconnection.
   2. Shut down all electrical circuits posing a potential hazard on the job. Exact electrical arrangements will be tailored to the particular space and systems involved. Potential for electrical shock is a major threat to life in a work area where large amounts of water will be utilized. Electrical lines that are used to power work lights and equipment will conform to all electrical safety standards and will be protected by ground fault interrupters and kept off the floor area.
   3. Maintain separation of non-authorized people from the work area.
   4. Maintain existing building in a locked, secure, and weather tight condition throughout the environmental remediation and demolition period.

B. The Abatement Contractor will repair any damage caused by any phase of the work operations to connecting properties landscape, sidewalks, storm drains, unless otherwise noted in writing or identified for demolition. Abatement Contractor is responsible for all clarifications. All damage will be repaired at the cost of the Abatement Contractor.

C. Keep all public and work areas free from accumulation of waste, rubbish, or construction debris. Environmental Contractor will maintain the cleanliness of the work site on daily and/or weekly bases. Keep all work areas locked at the end of each workday.

D. Smoking or other tobacco use or open fires will not be permitted on the premises. A smoking area may be designated by the building owner's representative. If a smoking area is designated, the Environmental Contractor will be responsible for supplying a bucket(s) with sand for the butts and will be responsible for cleaning of all butts and/or other trash located in the area.

12.0 DRIVEWAYS AND PARKING AREAS:

A. Lock automotive type vehicles, such as passenger cars, trucks, and other mechanized or motorized construction equipment, when parked and unattended, to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place or accessible to unauthorized persons. Environmental Contractor is responsible for the securing of all vehicles and thief will be at the owner of the vehicle responsibility, the building owner will not assume any responsibility for thief and/or damage to vehicles.

B. The contractor is responsible for supplying temporary storage required for storage of equipment and materials for duration of project. As identified in the UNC Planning and Construction Design Guidelines, the contractor's temporary facilities, including trailer and storage dumpsters, will be maintained in the areas designated by UNC Chapel Hill Parking Services in the Department of Public Safety (919.962.2693). Parking will be allowed in areas designated by Mr. Adrian Naylor.

C. Universal and hazardous materials and waste may be accumulated and temporarily stored on UNC property, but storage should not exceed 30 days except for extremely hazardous materials, for which arrangements should be made to remove the material from the premises as soon as is practicable. The contractor will provide locked storage for hazardous materials and waste with a clearly marked and labeled section specifically devoted to hazardous waste. Satellite Accumulation Rules should be followed until a total of 55 gallons of waste is accumulated. Once that threshold has been crossed, less than 90-day storage requirements must be implemented. The contractor will clearly identify the storage areas with proper signage and secure the area.

D. The hazardous and universal waste accumulation area will be pre-approved by UNC and the designer before wastes are stored there. The areas will be open for inspection by the UNC Environment Health and Safety (UNC EHS) or designer upon request. Hazardous waste accumulation area shall be locked when not in use.

E. The contractor is responsible for keeping the staging area secure. Waste materials will be protected from the weather and stored off the ground. The contractor will complete inspections of the waste storage area on a weekly basis and complete a daily inspection log. The contractor will keep the inspection forms in a project logbook on-site and provide copies to UNC EHS and/or the designer upon request. The contractor shall confirm that containers are secure and not leaking, and wastes are segregated into compatible groups and is properly labeled.

F. The contractor shall maintain an adequate quantity of spill response supplies to contain, at a minimum, 115% of accumulated waste. If a spill or leak is detected, the contractor shall immediately contact UNC-EHS. The spill or leak should be contained as soon as it is safe to contain. The contractor should clean the spilled material and contain it according to federal, state and local regulations and guidelines. UNC-EHS will assist the contractor in completing the required paperwork, including reporting and regulatory agency notification, as required.

13.0 NOTIFICATIONS

A. ALL OTHER TRADES: The disturbance or dislocation of asbestos-containing or contaminated materials, the removal of PCB Ballast, and fluorescent light tubes during the demolition may cause a release into the building's atmosphere, thereby creating a potential health hazard to workers and building occupants. Take appropriate continuous measures as necessary to protect neighboring property and occupants from the potential hazard of exposure to airborne asbestos, airborne mercury and/or other contaminates. Such

measures shall include the procedures and methods described herein, and compliance with regulations of applicable federal, state, and local agencies.

B. NOTIFY EMERGENCY SERVICE AGENCIES: Including fire, ambulance, police, or other agencies that may service the remediation work site in case of an emergency. Notification is to include methods of entering work area, emergency egress locations, modifications to fire notification or fire fighting equipment, and other information needed by agencies providing emergency services.

C. NOTIFICATIONS OF EMERGENCY: Any individual at the job site may notify emergency service agencies, if necessary, without effect on this Contract or the Contract Sum.

END OF SECTION

SECTION 02 80 30 – REMEDIATION SUBMITTALS

1.0 SUMMARY

A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including:

1. Contractor's construction schedule
2. Daily construction reports
3. Shop Drawings
4. Samples (as required)
5. Miscellaneous Submittals

2.0 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.

B. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

C. Coordinate transmittal of different types of submittals for related elements of the work so processing is not delayed by the need to review submittals concurrently for coordination.

D. The Owner's Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

E. Processing: Allow sufficient review time so that project will not be delayed because of the time required to process submittals, including time for re-submittals.

F. Submittal Deviations: Indicate in the front of the submittal package, any deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

G. Transmittal Form: Submittals can be submitted as an attachment in an email transmittal or a hard copy.

3.0 CONTRACTOR'S JOB SPECIFIC PLAN (SEE SECTION 02 80 20 - REMEDIATION COORDINATION)

A. Schedule: Provide proposed detailed schedule including work dates, work shift time, number of employees, dates of start and completion including dates of preparation work, removal, demolition, and final inspection dates. Include in the schedule any holidays that the contractor expects to work. Building Owner or Building Owner's Representative will give approval on all scheduling.

B. Work Stages: Indicate important stages of construction for each major portion of the work, including clearance testing. Include indication of start and finish times for the following:
1. Submittal of all contractual paperwork
2. Set up of and/or loading of equipment onsite
3. Installation of fencing along the site parameter
4. Complete any utility cut-offs and/or connections that is necessary prior to the beginning of the project
5. Preparation for the Environmental Remediation work
6. Environmental Remediation
7. Clearance testing
8. Substantial Completion

C. Distribution: Following response to the initial submittal, print and distribute copies to the Owner's Representative, Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project Administrator's field office, project meeting room, and temporary field office. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

D. Schedule Updating: Revise the schedule after each meeting or activity, where revisions have been recognized or made. Issue the updated schedule concurrently with report of each meeting.

4.0 SUBMITTAL SCHEDULE

A. Listing: At the end of this section is a listing of the principal submittals required for the work. This listing is not necessarily complete, nor does the listing reflect the significance of each submittal requirement. The listing is included only for the convenience of users of the Contract Documents. CHECK THE SPECIFICATION FOR ADDITIONAL SUBMITTALS THAT MAYBE REQUIRED. After review and action on the Contractor's construction schedule, prepare a complete schedule of submittals. Submit the schedule of submittals within 10 days of the date required for establishment of the Contractor's construction schedule or within the designated period indicated during the Pre-Construction meeting.

B. Prepare the submittal schedule in chronological order; include submittals required before start of construction.

C. Building Owner will not provide Contractor with office space. It will be the contractor’s responsibility to secure an office area by providing an onsite modular unit.

5.0 MISCELLANEOUS SUBMITTALS:

A. Safety Data Sheets: Process safety and data sheets as "product data."

B. Inspection and Test Reports: Classify each inspection and test report as being either "shop drawings" or "product data" depending on whether the report is specially prepared for the project, or a standard publication of workmanship control testing at the point of production. Process inspection and test reports accordingly.

C. Records of Actual Work: Furnish 1 copy of records of actual work, one of which will be returned for inclusion in the record documents as specified in section "Project Closeout".

D. Closeout Submittals: Refer to section "Project Closeout" and to individual sections of these specifications for specific submittal requirements of project closeout information.

E. The Building Owner or his representative may request additional submittals if required by the project.

SUBMITTAL CHECK LIST

Submittal for section Before Start of Work must be turned in to the Owner or the Owner's Representative at the Pre-Construction Meeting and no later than 5 calendar days before the start of work. The Owner or Owner's Representative will then give the contractor written permission to begin work. The Contractor will not begin work without written permission. If a delay is due to Environmental/Demolition Contractor's non-responsible submittal requirements there will be no additional time allotted to the contractor for the project.

Before Start of Work and updated as the work progresses:

____ 1 Copy of completed NC-DHHC Asbestos Removal and Demolition Notification Form filled out by Contractor
____ 2 Copy of NC-DHHC authorization to proceed with project ID number, fee information, and disposal site authorization for asbestos abatement and for the demolition
____ 3 Copy of North Carolina Contractor's License.
____ 4 Copy of any subcontractors' licenses, if applicable.
____ 5 Performance and Payment Bond with proper Project Identification
____ 6 Certificate of Insurance with proper project identification and Certificate of Insurance from any subcontractors.
____ 7 Project References
____ 8 Copies of NC-DHHC Accreditations for each individual that will be working on the job site. (Worker's that have submitted their training certification to NC-DHHC who have not yet received their license must be verified by the environmental remediation our office and approved in writing before they are allowed on the job site.)
____ 9 Completed Notification Log Form with information for contingency plans and notification of local emergency personnel
____ 10 Project Title Page with Contractor's Acknowledgment of proper contact procedures for project administration problems, including a list of phone numbers for both the consultant and the building owner and an exclusive list of the personnel to be contacted
____ 11 A complete detailed job specific plan that includes a timeline exemplifying all phasing of the work to be performed.
____ 12 Safety Data Sheets for any chemicals (i.e. surfactants, etc.) that will be utilized during the remediation.
____ 13 The name of the asbestos and the construction landfill that will be utilized
____ 14 List of contact telephone numbers including Project Manager, Superintendent, Air Monitor, SAM, local Police Department and Fire Department.
____ 15 Documentation of lead training for the supervisor(s) and workers in accordance with OSHA 29 CFR 1926.62

Submittal for the section Periodically during Work or before Project Closeout must be submitted to the Owner or Owner's Representative with the Progressive Payment Request. If Progressive Payments are not indicated, then the submittals must be turned into the Owner or Owner's Representative Office before the Project Closeout. Contractor must have written permission from Owner or Owner's Representative before beginning Project Closeout.

PERIODICALLY DURING WORK OR BEFORE PROJECT CLOSEOUT

____ 16 Copy of containment checklist completed by the IH and signed by the Contractor including original smoke test documentation
____ 17 Daily Logs filled out and signed by the Project Supervisor
____ 18 Daily Sign In\Sign Out Sheets
____ 19 Contractor's copy of Negative and/or Initial Exposure Assessment
____ 20 Contractor's copy of Daily Personnel Air Monitoring Results
____ 21 Accident and Incident Investigation Report
____ 22 Visitor Log and signed Visitor's Authorization Form

____ 23 Documentation of Manometer Readings, Asbestos Filtration (AFD) and Water Filtration (WFD) Device Inspections, documentation of smoke tests per shift
____ 24 Application for Final Visual Inspection(s)
____ 25 Periodical check of site demolition equipment

Submittal for the section At Project Closeout must be submitted to the Owner or Owner's Representative with the Final Payment Request.

AT PROJECT CLOSEOUT*

____ 26 Certification of Removal
____ 27 Asbestos Chain-of-Custody Form (Trip Ticket) completed by and signed by the Contractor Representative, Transporter and Disposal Site Representative within 35 days as required by NESHAPS 61.150 vii(3)(4)
____ 28 Contractor Application for Payment (Invoice)

NOTE: PROJECT CLOSEOUT CANNOT BEGIN UNTIL AIR CLEARANCE RESULTS ARE OBTAINED

Copies of the submittals for the section Items to be Submitted by the Air Monitoring Firm should also be obtained by the Contractor and included in the Contractor Submittals as indicated above.

ITEMS TO BE SUBMITTED BY THE AIR MONITORING FIRM(S)

____ 29 Background and Area Air monitoring reports
____ 30 Final Clearance Air Monitoring Reports (This must be completed before Project Closeout begins.)

END OF SECTION

SECTION 02 80 40 – REMEDIATION REGULATIONS-STANDARDS

1.0 GENERAL

A. A substantial amount of specification language constitutes definitions for terms found in other contract documents, including the drawings. Certain terms used in Contract Documents are defined in this article.

B. This section sets forth governmental regulations and industry standards that are included and incorporated herein by reference and made a part of the specification. This section also sets forth those notices and permits that are known to the Owner and that must be applied for and received, or which must be given to governmental agencies before start of work.

C. Requirements include adherence to work practices and procedures set forth in applicable codes, regulations, and standards.

D. Requirements include obtaining permits, licenses, inspections, releases, similar documentation, as well as payments, statements, and similar requirements associated with codes, regulations, and standards.

E. The contractor shall assume full responsibility and liability for compliance with applicable federal, state and local regulations pertaining to work practices, waste handling, protection of workers, visitors to the site and persons occupying areas adjacent to the site.

F. Unless modified by this project specification, specifications for work including cutting, remediation, stripping, removal, repair and disposal work shall conform to the updated versions of the following guidelines and standards, as they become available:

2.0 REFERENCE THE FOLLOWING PUBLISHED REGULATIONS AND GUIDANCE DOCUMENTS

A. The Environmental Protection Agency (EPA) documents listed are for the Contractor's information. EPA publications can be ordered from (800) 490-9198.
   1. Resource Conservation and Recovery Act (RCRA)
   2. 40 CFR Parts 260-272, Solid and Hazardous Waste (RCRA)
   3. 40 CFR, Part 122 and 125: National Pollutant Discharge Elimination System, Clean Water Act
   4. 40 CFR, Parts 260–272: Solid and Hazardous Wastes, (RCRA)
   5. 40 CFR, Subchapter J, Parts 300-373: Superfund Emergency Planning and Community Right-to-Know Programs
   6. 49 CFR, Parts 238-282 Code of Federal Regulations controls the management, disposal of solid, and hazardous waste.
   7. Comprehensive Environmental Response Compensation and Liability Act
   8. National Emissions Standards for Hazardous Air Pollutants Asbestos," 40 CFR Part 61, Subpart M
   9. "General Provisions," 40 CFR, Part 61, Subpart A
   10. "Guidance for Controlling Asbestos-Containing Materials in Buildings" June 1985. (EPA # 560/5-85-024)
   11. "Asbestos-Containing Materials in Schools," 40 CFR Part 763, Subpart E including appendices

B. The Department of Transportation (DOT) documents listed are for the Contractor’s information.
   1. Hazardous Materials Transportation Act as amended
   2. 49 CFR Parts 171 through 177

C. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) documents listed are for the Contractor's information. OSHA publications can be obtained at www.osha.gov.
1. "Respiratory Protection," Title 29, Part 1910, Section 134 of the Code of Federal Regulations
2. "Safety and Health Regulations for Construction," Title 29, Part 1926 of the Code of Federal Regulations
3. "Access to Employee Exposure and Medical Records," Title 29, Part 1910, Section 1020 of the Code of Federal Regulations
4. "Hazard Communication," Title 29, Part 1910, Section 1200 of the Code of Federal Regulations
5. "Specifications for Accident Prevention Signs and Tags," Title 29, Part 1910, Section 145 of the Code of Federal Regulations
6. "Hazardous Waste Operations and Emergency Response," Title 29, Part 1926, Section 65 of the Code of Federal Regulations
7. "Toxic and Hazardous Substances," Title 29, Part 1926, Subpart Z of the Code of Federal Regulations
8. "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite," Final Rules," Title 29, Part 1910, Section 1001 and Part 1926, Section 1101 of the Code of Federal Regulations
9. "General Safety and Health Provisions," Title 29, Part 1910, Subpart C of the Code of Federal Regulations
10. "Lead," Title 29, Part 1926, Section 62 of the Code of Federal Regulations
11. Federal Standard 313A: Safety Data Sheets, Preparation and Submission o
12. "Illumination", Title 29, Part 1926.56, Subpart D of the Code of Federal Regulations

D. North Carolina State, county or town agencies documents listed are for the Contractor's information.
1. Orange Water and Sewer Use Ordinance, Orange County, North Carolina
2. Orange County Regulated Recyclable Materials Ordinance
3. "North Carolina Occupational Safety and Health Standards for the Construction Industry," 29 CFR Part 1926 as adopted by T13 NCAC 07F .0201 and shipyard T13 NCAC 07F.0500
4. North Carolina General Statutes, including Chapters 95, 97, 130
5. Town of Chapel Hill Noise Ordinance-Ordinance Number 2001-09-24/O-8
6. The State Building Code
7. North Carolina Construction Manual, Division of State Construction, Department of Administration, Section 112.4 Electrical
8. North Carolina Administrative Code, Title 15A, Chapter 13 Solid Waste Management
9. Wastewater Permit discharge requirements for UNC Chapel Hill
10. Occupational Safety and Health Act of North Carolina (OSHANC)
11. North Carolina Asbestos Hazard Management Program Rules as adopted by 10A NCAC 41C .0600.
12. North Carolina Rules 10A NCAC 41C.0900-Lead-Based Paint Hazard Management Program for Renovation, Repair and Painting

E. American National Standards Institute (ANSI) documents listed are the Contractor's information. These documents can be order online at the https://webstore.ansi.org.
1. "Fundamentals Governing the Design and Operation of Local Exhaust Systems," Z9.2-1979
2. "American National Standard for Respiratory Protection Respiratory Use - Physical Qualifications for Personnel," Z88.6-1984
3. ASTM International, "Standard Practice for Visual Inspection of Asbestos Abatement Projects", E 1369-05
4. "Practices for Respiratory Protection," Z88.2-1992

5. “Safety and Health Program Requirements for Demolition Operations-American National Standard for Construction and Demolition Operations” ANSI/ASSE A10.6-2006
6. “Safety Requirements for Steel Erection—American National Standard for Construction and Demolition Operations” ANSI/ASSE A10.13-2001
7. Safety Requirements for Excavation—American National Standard for Construction and Demolition Operations ANSI/ASSE A10.12-1998 (R2005)
8. Safety and Health Program Requirements for Multi-Employer Projects—American National Standard for Construction and Demolition Operations ANSI/ASSE A10.33-1998 (R2004)

F. Documents published by the following professional electrical engineering, fire or other associations:
1. Underwriters’ Laboratories (UL)
2. National Electrical Manufacturers’ Association (NEMA)
3. National Fire Protection Association (NFPA)
4. National Electric Code
5. National Electric Safety Code
6. Electrical Testing Laboratory
7. American National Standards Institute (ANSI)
8. Institute of Electrical and Electronic Engineers (IEEE)
9. Requirements for Fire Detection and Alarm Systems/Smoke Detectors Meeting the State on NC Requirements, Department of Insurance, State of North Carolina - Latest Edition

G. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable codes, regulations, and standards have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith.

H. The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, State, and local regulations pertaining to accreditations, licensing, work practices, hauling, disposal, protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable Federal, State, and local regulations. The Contractor shall hold the Owner and Owner's Representative harmless for failure to comply with any applicable accreditations, licensing, work, hauling, disposal, safety, health, or other regulation on the part of himself, his employees, or his subcontractors.

3.0 INDUSTRY STANDARDS

A. Applicability of Standards: Except where Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the Project Site for reference.

1. Referenced industry standards take precedence over standards that are not referenced but recognized in the construction industry as applicable.

2. Unreferenced industry standards are not directly applicable to the work, except as a general requirement of whether the work complies with recognized construction industry standards.

B. Publication Dates: Where compliance with an industry standard is required, comply with standard in effect as of date of Contract Documents.

1. Updated Standards: At the request of the Owner's Representative, Contractor or authority having jurisdiction, submit a Change Order proposal where applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected. The Owner's Representative will decide whether to issue a Change Order to proceed with the updated standard.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Owner's Representative for a decision before proceeding.

1. Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Owner's Representative for decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entities' construction activity. Copies of applicable standards are not bound with the Contract Documents.

E. Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source.

F. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Owner's Representative reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

G. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where acronyms or abbreviations are used in the Specifications or other Contract Documents they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.

H. Permits, Licenses and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence and records established in conjunction with compliance with standards and regulations bearing upon performance of the work.

1. A North Carolina General Contractor’s is required for this Project.

2. The Environmental/Demolition Contractor will be responsible for obtaining permits necessary for the environmental and demolition. Any inspection required for this work is the responsibility of the Contractor to request.

I. Local Requirements: Abide by all local requirements that govern asbestos abatement work or hauling and disposal of asbestos waste materials.

J. The insurance certificate/policy shall state that Sunset clause or similar clause or clauses of intent are not included in the coverage. In addition, Asbestos Pollution Liability Insurance is required. A

completed Certificate of Insurance for Asbestos Pollution Liability Insurance must be obtained and maintained throughout the project.

1. Contractor must be able to supply an original Certificate of Insurance prior to beginning showing evidence of coverage in effect for General Liability and Pollution Liability, and Automobile Liability with no less coverage than $10 million ($10,000,000) coverage and Worker's Compensation with no less coverage than $1 Million ($1,000,000) of each category in accordance with the outlined specification and shall state that Sunset Clause or similar clause or clauses of intent are not included in the coverage.

4.0 LAND DISTURBING ACTIVITIES:

A. This permit is not required.

5.0 NOTIFICATIONS:

A. Send Written Notification as required by USEPA National Emission Standards for Hazardous Air Pollutants (NESHAPS) Asbestos Regulations (40 CFR 61, Subpart M) to the regional Asbestos NESHAPS Contact at least 10 days prior to beginning any work on asbestos-containing materials. Send notification on the appropriate form completely filled in to the following address:

1. US MAIL DELIVERY:
NCDHHS-DIVISION OF PUBLIC HEALTH
1912 MAIL SERVICE CENTER
RALEIGH, NC 27699-1912
TELEPHONE: 919-707-5950

2. FOR EXPRESS DELIVERY SERVICES
HEALTH HAZARDS CONTROL UNIT
5505 SIX FORKS ROAD, 2nd FLOOR, Room D-1
Raleigh, NC 27609

B. Send written Notification and pay the fee for the Demolition of the Building as required by North Carolina Department of Health and Environmental Control 10 working days prior to beginning any demolition activities.

1. US MAIL DELIVERY:
NCDHHS-DIVISION OF PUBLIC HEALTH
1912 MAIL SERVICE CENTER
RALEIGH, NC 27699-1912
TELEPHONE: 919-707-5950

2. FOR EXPRESS DELIVERY SERVICES
HEALTH HAZARDS CONTROL UNIT
5505 SIX FORKS ROAD, 2nd FLOOR, Room D-1
Raleigh, NC 27609

6.0 WASTE DISPOSAL PERMITS:

A. All asbestos containing waste is to be transported by an entity maintaining a current "Waste Shipment Record" specifically for friable asbestos-containing materials, as required for transporting of waste asbestos-containing materials to a disposal site.

B. Construction waste is to be taken to an approved construction and debris (C&D) landfill.

7.0 REFERENCES FOR SOLID AND HAZARDOUS WASTE

The Solid Waste Disposal Act of 1965, as amended, also known as the Resource Conservation and Recovery Act (RCRA) is the Federal Act that controls the management and disposal of solid

and hazardous waste. The Federal Regulations (enforceable requirements) for RCRA can be found in Title 40 of the Code of Federal Regulations (CFR) Parts 238-282.

8.0 LICENSES:
Maintain current accreditations and/or licenses as required by North Carolina State or local jurisdictions for companies and employees for the removal, transporting, disposal, or other regulated activity relative to the work of this contract.

9.0 POSTING AND FILING OF REGULATIONS

A. Post all notices required by applicable federal, state, and local regulations. Maintain two (2) copies of applicable federal, state, and local regulations and standards. Maintain one copy of each at job site. Keep on file one copy of each in Contractor's office.

B. Check all sections of the specification for further codes, regulation, and or standards that may be required.

END OF SECTION

SECTION 02 80 50–HAZARDOUS MATERIALS ASSESSMENT

SECTION 02 82 13.1 - WORKER PROTECTION

1.0 DESCRIPTION OF WORK:

A. This section describes the equipment and procedures required for protecting workers against asbestos, and other workplace hazards except for respiratory protection, See Section 02 82 13.2 for Respiratory Protection.

2.0 DEMOLITION ACTIVITIES

A. During demolition, the Contractor must follow all OSHA safety Regulations that pertain to the specific task as it is performed. This section specifically references 1926.95 Personal Protective and Life Saving Equipment, Criteria for personal protective equipment.

B. Application: Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

C. Employee-owned equipment: Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

D. Design: All personal protective equipment shall be of safe design and construction for the work to be performed.

3.0 WORKER PROTECTION:

A. Personal protective equipment for workers should be clearly specified in the site-specific health and safety plan for the project. A minimum of Level C protection is recommended.

4.0 ASBESTOS

A. MEDICAL EXAMINATIONS:
Provide medical examinations for all workers who may encounter an airborne fiber level of 0.1 f/cc or greater for an 8-hour Time Weighted Average. Provide medical examinations for all workers who will enter the Regulated Work/Isolation Area for any reason. Examination shall as a minimum meet OSHA requirement as set forth in OSHA 29 CFR 1910.134 AND 29 CFR 1926.1101(m). In addition, provide an evaluation of the individual's ability to work in environments capable of producing heat stress in the worker.

B. The Medical Examination must have been conducted within the previous 12 months as part of compliance with OSHA medical surveillance requirements for each worker who is to enter the Regulated Area.

C. PROTECTIVE CLOTHING:

1. Coveralls: Provide disposable full-body coveralls and disposable head covers and require that they be worn by all workers in the Work/Isolation Area. Provide a sufficient number for all required changes, for all workers in the Work/Isolation Area. Each time Work/Isolation Area is entered remove all street clothes in the Changing Room of the Personnel Decontamination Unit and put on new disposable coverall, new head cover, and a clean respirator. Disposable undergarments, *nylon or Under Armor™ type* clothing must be worn under disposable coveralls. Proceed through shower room to equipment room and put on work boots.

2. Boots: Provide work boots with non-skid soles, and where required by OSHA, foot protection, for all workers. Provide boots at no cost to workers. Do not allow boots to be removed from the Work/Isolation Area for any reason, after being contaminated with asbestos-containing material. All boots will have the toes of painted a fluorescent color that will be agreed upon by the environmental/demolition contractor and the project manager. Thoroughly clean, decontaminate and bag boots before removing them from Work/Isolation Area at the end of the work. Package and label boots as asbestos-contaminated waste at the end of the work. Any worker found wearing the boots that have been designated for the work area outside of the work area, the worker may be asked to be reprimanded up to leaving the work site for the day or permanently.

3. Hard Hats: Provide head protection (hard hats) as required by OSHA for all workers. Provide hard hats of type with plastic strap type suspension. Require hats be worn in the building and within all work areas outside the facility during the project. Thoroughly clean, decontaminate, and bag hats before removing them from Work/Isolation Area at the end of the work. Package and label hats as asbestos-contaminated waste at the end of the work. If hardhats are required within the asbestos work area, these hats are also to be painted with the same fluorescent color paint as the boots.

4. Goggles: Provide eye protection (goggles) as required by OSHA for all workers involved in scraping, spraying, or any other activity that may potentially cause eye injury. Thoroughly clean, decontaminate and bag goggles before removing them from Work/Isolation Area at the end of the work. Package and label goggles as asbestos-contaminated waste at the end of the work.

5. Gloves for inside asbestos areas: Provide work gloves to all workers and require that they be worn at all times in the Work/Isolation Area. Do not remove gloves from Work/Isolation Area and dispose of as asbestos-contaminated waste at the end of the work. Provide one color glove for inside the asbestos containment area and another color for outside the work area.

6. Gloves: Provide work gloves to all workers and require that they be worn at all times in the Work/Isolation Area.

7. Fall Protection: Harness with lanyard if required by OSHA

5.0 PROVIDE ADDITIONAL PROTECTIVE EQUIPMENT DURING REMEDIATION FOR IH, PROJECT MANAGER, AND/OR REGULATORY PERSONNEL:

A. Respirator filters, disposable coveralls, head covers, and footwear covers shall be provided by the Contractor for the Owner, Owner's Representative, Project Administrator, and other authorized representatives who may inspect the job site. Provide six (6) complete coveralls and, where applicable, six (6) respirator filters changes per day for these visitors.

B. PAPRs are required on the jobsite contractor until a Negative Exposure Assessment is provided, along with a minimum two (2) extra units for the Project Administrator and/or Owner to utilized if necessary.

6.0 DECONTAMINATION PROCEDURES:

A. Require all workers to adhere to the following personal decontamination procedures whenever they leave the Work/Isolation Area:

B. When exiting area, remove disposable coveralls, disposable head covers, and disposable footwear covers or boots in the equipment room.

C. Still wearing respirators, proceed to showers. Showering is mandatory. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:

1. Thoroughly wet body including hair and face. If using a Powered Air-Purifying Respirator (PAPR) hold blower unit above head to keep canisters dry if applicable.
2. With respirator still in place thoroughly wash body, hair, respirator face piece, and all parts of the respirator except the blower unit and battery pack on a PAPR. Pay particular attention to seal between face and respirator and under straps.
3. Take a deep breath; hold it and/or exhale slowly, completely wet hair, face, and respirator. While still holding breath, remove respirator and hold it away from face before starting to breath.
4. Carefully wash the face piece of the respirator inside and out.

D. When using PAPR: shut down in the following sequence, first cap inlets to filter cartridges, and then turn off blower unit (this sequence will help keep debris which has collected on the inlet side of filter from dislodging and contaminating the outside of the unit). Thoroughly wash blower unit and hoses. Carefully wash battery pack with wet rag. Be extremely cautious of getting water in battery pack, as this will short out and destroy battery.

7.0 WITHIN REGULATED AREA:

A. Require that workers NOT eat, drink, smoke, chew tobacco or gum, or apply cosmetics in the Regulation and/or Work/Isolation Area. To eat, chew, drink, or smoke, workers shall follow the procedure described above, and then dress in street clothes before entering a designated non-regulated area.

B. If a worker is found violating an OSHA respirator requirement, the supervisor may be requested to reprimand the worker including leaving the work site for the day or permanently.

END OF SECTION

SECTION 02 82 13.13 – GLOVEBAG ASBESTOS ABATEMENT

1.0 GENERAL GLOVEBAG REMOVAL PROCEDURES

A. The removal of pipe insulation impacted by the renovation within the interior of the building shall include the glovebag method. A remote decontamination unit shall be contiguous to the regulated area. The onsite IH shall observe the smoke test to ensure the glovebag(s) are properly sealed. Pipe insulation is suspected to be hidden in walls and pipe chases.

Prior to the glovebag method being performed on sections of piping, the contractor shall wrap manageable lengths of piping with 6-mil polyethylene sheeting and reinforce the wrapping with duct tape creating a candystriped effect. Two layers of 6-mil poly shall be utilized on each section of piping and the appropriate OSHA, DOT and Waste Generator label should be attached. Glovebag the ends of each section of piping prior to cutting the pipes. The entire piping component should be disposed of as asbestos waste.

Use glovebag procedures in compliance with Federal and state regulations for the removal of small sections of TSI. Place a Primary Barrier of at least one layer of 6 mil polyethylene as a drop cloth below material to be removed extending at least 10 feet in all directions. Provide minimum 6 mil polyethylene, polyvinylchloride or equivalent plastic sack with two inward projecting long sleeve gloves or mittens, preprinted with same warning notice as a disposal bag, equipped with a pouch for storage of tools, with designated location for wand or HEPA vacuum wand, and sufficient capacity to hold removed materials and permit sealing as specified. Provide a hand pump type pressure-can garden sprayer fabricated out of either metal or plastic, equipped with a metal wand at the end of a hose that can deliver a stream or spray of liquid under pressure. Check pipe where the work will be performed. Wrap damaged (broken lagging, hanging, etc.), pipe in 6 mil plastic and "candy-stripe" with duct tape. Place one layer of duct tape around undamaged pipe at each end where the glove bag will be attached. Slit top of the glove bag open (if necessary) and cut down the sides to accommodate the size of the pipe (about two inches longer than the pipe diameter). Place necessary tools into pouch located inside glove bag. This will usually include at least the following items: bone saw, utility knife, rags, scrub brush, wire cutters, tin snips and pre-wetted cloth. Place one strip of duct tape along the edge of the open top slit of glove bag for reinforcement. Place the glove bag around section of pipe to be worked on and staple top together through reinforcing duct tape. Next, duct tape the ends of glove bag to pipe itself, where previously covered with plastic or duct tape. Use smoke tube and aspirator bulb to test seal. Place tube into water sleeve (two-inch opening to glove bag) squeezing bulb and filling bag with visible smoke. Remove smoke tube and twist water sleeve closed. While holding the water sleeve tightly, gently squeeze glove bag and look for smoke leaking out, (especially at the top and ends of the glove bag). If leaks are found, tape closed using duct tape and re-test. Insert wand from garden sprayer through water sleeve. Duct tape water sleeve tightly around the wand to prevent leakage. Thoroughly wet material to be worked on with amended water or removal encapsulant and allow to soak in. Wet adequately to penetrate and soak material through to substrate. One person places his hands into the long-sleeved gloves while the second person directs garden sprayer at the work. Use bone saw, if required, to cut insulation at each end of the section to be removed. A bone saw is a serrated heavy gauge wire with ring-type handles at each end. Throughout this process, spray amended water or removal encapsulant on the cutting area to keep dust to a minimum. Remove insulation using putty knives or other tools. Place pieces in bottom of bag without dropping. Rinse all tools with water inside the bag and place back into pouch. Using scrub brush, rags and water, scrub and wipe down the exposed pipe. Remove water wand from water sleeve and attach the small nozzle from HEPA-filtered vacuum. Turn on the vacuum only briefly to collapse the bag. Remove the vacuum nozzle, twist water sleeve closed and seal with duct tape. From outside the bag, pull the tool pouch away from the bag. Place duct tape over twisted portion and then cut the tool bag from the glove bag, cutting through the twisted/taped section. Contaminated tools may then be placed directly into next glove bag without cleaning. Alternatively, tool pouch with the

tools can be placed in a bucket of water, opened underwater, and tools cleaned and dried. Discard rags and scrub brush with asbestos waste. With removed insulation in the bottom of the bag, twist the bag several times and tape it to keep the material in the bottom during removal of the glove bag from the pipe. Slip a 6-mil disposal bag over the glove bag (still attached to the pipe). Remove tape or cut bag and open the top of the glove bag and fold it down into disposal bag. Clean all surfaces in the Work Area using disposable cloths wetted with water with surfactant or removal encapsulant added. When these surfaces have dried, clean with a HEPA filtered vacuum. Seal exposed ends of remaining pipe insulation and exposed pipe. Collapse the bag with a HEPA vacuum twist top of bag, seal with at least 3 wraps of duct tape, bend over and seal again with at least 3 wraps of duct tape.

2.0 FINAL CLEAN UP

A Dispose of all rags, plastic sheet, etc. in accordance with requirements of Section 02 82 33.3, "Disposal of Environmental Containing Waste Material".

B Decontaminate Equipment: After the completion of all work, decontaminate all equipment and machinery used for work of this section. Accomplish decontamination as required by the section on Project Decontamination.

C Compatibility: At the completion of all work, leave substrates in such a state as to comply with all requirements and recommendations of manufacturer for replacement materials.

END OF SECTION

SECTION 02 82 13.2 - RESPIRATORY PROTECTION

1.0 GENERAL

This section covers work during the remediation of asbestos, other hazardous materials and during the demolition phase of the work.

Inspectors entering the building will be required to wear a minimum of a half mask air purifying respirator and full disposable suits. Workers will be required to wear a PAPR and full disposable suit.

2.0 DESCRIPTION OF WORK:

A. Permissible practice.

1. In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.

2. Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators that are applicable and suitable for the purpose intended.

3. Instruct and train each worker involved in asbestos abatement or maintenance and repair of Class I, II, and III asbestos-containing materials in proper respiratory use. Require that each worker always wear a respirator, properly fitted on the face in the Work/Isolation Area from the start of any operation that may cause airborne asbestos fibers until the Work/Isolation Area is completely decontaminated. Use respiratory protection appropriate for the fiber level encountered in the workplace or as required for other toxic or oxygen-deficient situations encountered.

3.0 RESPIRATORY PROTECTION PROGRAM:

A. Comply with ANSI Z88.2 - 1992 "Practices for Respiratory Protection" and OSHA 29 CFR 1910.134, 29 CFR 1910.1000, and CFR 1926.1101. Require that respiratory protection be used at all times where there is any possibility of disturbance of asbestos-containing materials whether intentional or accidental. Require that a respirator be worn by anyone in a Work/Isolation Area at all times, regardless of activity, during a period that starts with any operation, which could cause airborne fibers, until the area has been cleared for re-occupancy in accordance with Section 02 82 33.2.

B. The employer shall provide respirators and ensure that they are used where required. Respirators shall be used in the following circumstances:

C. Asbestos

1. During all Class I asbestos jobs a minimum of powered air purifying respirator (PAPR).
2. During all Class II work where the ACM is not removed in a substantially intact state a minimum of powered air purifying respirator (PAPR).
   During all Class II and III asbestos jobs where the employer does not produce a "negative exposure assessment".
3. During all Class III jobs where TSI or surfacing ACM or PACM is being disturbed.
4. During all Class IV work performed within the regulated areas where employees performing other work are required to wear respirators.

5. During all work where employees are exposed above the TWA (0.1 f/cc) or excursion limit (1.0 f/cc).

4.0 STANDARDS:

A. Except to the extent that more stringent requirements are written directly into the Contract Documents, the following regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies were bound herewith. Where there is a conflict in requirements set forth in these regulations and standards, meet the more stringent requirement.

1. OSHA-U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Standards 29 CFR 1910, Section 1001 and Section 1910.134 and 29 CFR 1926.1101.
2. CGA-Compressed Gas Association, Inc., New York, Pamphlet G-7, "Compressed Air for Human Respiration", and Specification G-7.1 "Commodity Specification for Air".
3. ANSI-American National Standard Practices for Respiratory Protection, ANSI Z88.2-1992.
4. NIOSH-National Institute for Occupational Safety and Health

5.0 FIT TESTING:

A. Fit Testing Procedures--General Requirements

1. Initial Fitting: Provide initial fitting of respiratory protection. Fit the respirator to be actually worn by each individual as needed. Allow an individual to use only those respirators for which training and fit testing has been provided.

2. At least once every year there after, check the fit of each worker's respirator by completing one of the fit test methods as outlined in OSHA 1910.134.

3. User seal (Fit) Check upon each wearing, require that each time a tight-fitting respirator is put on it be checked for fit with a positive and negative pressure fit test in accordance with the manufacturer's instructions or ANSI Z88.2 (1992).

6.0 ASBESTOS RESPIRATORY PROTECTION REQUIREMENTS:

A. Respiratory Protection that supplies an airborne fiber level inside the respirator at or below .01 f/cc as an 8-Hour Time Weighted Average (TWA) and/or .05 f/cc as a 30-Minute Short Term Excursion Limit (STEL) is the minimum level of protection allowed. Contractor is responsible for collecting air sampling data for TWA and STEL measurements.

B. For all Class I asbestos work.

1. Employers must provide employees a tight-fitting powered air-purifying respirator or a full facepiece, supplied-air respirator operated in the pressure-demand mode and equipped with either HEPA egress cartridges or an auxiliary positive-pressure, self-contained breathing apparatus (SCBA) whenever the employees are in a regulated area performing Class I asbestos work for which a negative exposure assessment is not available and the exposure assessment indicates that the exposure level will be at or below 1 f/cc as an 8-hour time-weighted average (TWA).

2. In addition, a full facepiece supplied-air respirator operated in the pressure-demand mode and equipped with an auxiliary positive-pressure SCBA whenever the employees are in a regulated area performing Class I asbestos work for which a negative exposure assessment is not available, and the exposure assessment indicates that the exposure level will be above 1 f/cc as an 8-hour TWA.

C. Half-face negative pressure respirator for Class II work at a minimum until the contractor conducts exposure monitoring and documents that employees on the job will not be exposed in excess of the

PEL's or otherwise makes a negative exposure assessment the contractor shall presume that the workers are exposed in excess of the TWA and excursion limit.

D. Therefore, an exposure assessment is necessary for OSHA compliance.

7.0 PERSONNEL AIR MONITORING:

A. Periodic Monitoring: The contractor shall conduct daily monitoring that is representative of the exposure of each worker who is assigned to work within a regulated area and who is performing Class I or II work, unless the contractor has a negative exposure assessment for the entire operation. EXCEPTION: When all workers required to be monitored daily are equipped with supplied-air respirators operated in the positive-pressure mode, the contractor may dispense with the daily monitoring required by this paragraph.

B. Termination of monitoring: If periodic monitoring reveals that worker exposures, as indicated by statistically reliable measurement, are below the permissible exposure limit and excursion limit the contractor may discontinue monitoring for those employees whose exposure are represented by such monitoring.

C. Additional monitoring: The contractor shall institute the exposure monitoring whenever there has been a change in process, control equipment, personnel or work practices that may result in new or additional exposure above the permissible exposure limit and/or excursion limit. Also, the contractor shall institute exposure monitoring when the employer has any reason to suspect that a change may result in new or additional exposure above the permissible exposure limit and/or excursion limit. Such additional monitoring is required regardless of whether a "negative exposure assessment" was previously produced for a specific job.

D. Observation of monitoring: The contractor shall provide affected employees and their designated representative an opportunity to observe any monitoring of workers exposure to asbestos conducted in accordance with OSHA CFR 1926.1101.

E. Special Notation: For all Class I and Class II jobs where the contractor cannot produce a negative exposure assessment, or where exposure monitoring shows that a PEL is exceeded, the contractor shall ventilate the Work/Isolation Area to move contaminated air away from the breathing zone of workers toward a HEPA filtration or collection device.

8.0 AIR PURIFYING RESPIRATORS:

A. Negative pressure - half or full facemask: Supply a sufficient quantity of respirator filters approved for asbestos, so that workers can change filters during the workday. Require that respirators be wet-rinsed, and filters discarded, each time a worker leaves the Work/Isolation Area. Require that new filters be installed each time a worker re-enters the Work/Isolation Area. Store respirators and filters at the job site in the changing room and protect totally from exposure to asbestos prior to their use. Equip full-face respirators with a nose cup or other anti-fogging device.

B. Powered air purifying - half or full face mask: Supply a sufficient quantity of high efficiency respirator filters approved for asbestos so that workers can change filters at any time that flow through the face piece decreases to the level at which the manufacturer recommends filter replacement. Require that regardless of flow, filter cartridges be replaced after 40 hours of use. Require that HEPA elements in filter cartridges be protected from wetting during showering. Require entire exterior housing of respirator, including blower unit, filter cartridges, hoses, battery pack, facemask, belt, and cords, and be washed each time a worker leaves the Work/Isolation Area. Caution should be used to avoid shorting battery pack during washing. Provide an extra battery pack for each respirator so that one can be charging while one is in use.

C. Filter Cartridges: Provide, at a minimum, HEPA type filters labeled with NIOSH and MSHA Certification for "Radionuclides, Radon Daughters, Dust, Fumes, Mists including Asbestos-

Containing Dusts and Mists" and color coded in accordance with ANSI Z88.2 (1992). In addition, a chemical cartridge section may be added, if required, for solvents, etc., in use. In this case, provide cartridges that have each section of the combination canister labeled with the appropriate color code and NIOSH/MSHA Certification.

D. Provide equipment capable of producing air of the quality and volume required by the above reference standards applied to the job site conditions and crew size. Comply with provisions of this specification if more stringent than the governing standard.

END OF SECTION

SECTION 02 82 13.3 – MONITORING AND SAMPLING REQUIREMENTS

1.0 GENERAL

A. This section describes the monitoring requirements for remediation of the asbestos containing/contaminated material. Unless clarified in other sections of this specification, the monitoring is at the cost of the building owner.

Exception Summary of Cost to the Contractor's:

1. Contractor's Personnel Monitoring for all contaminants.
2. TCLP for Hazardous Waste Identification (if applicable).
3. All Waste Disposal Costs.

B. The building owner, building owner representative, and/or project designer shall be responsible for the coordination and contracting of an industrial hygiene firm. The building owner will pay for the services of the industrial hygiene firm.

C. The asbestos air monitoring shall be completed under the direct supervision of a North Carolina accredited Supervising Air Monitor (SAM), except for personnel sampling performed by the contractor to satisfy OSHA requirements. A SAM's responsibilities include:

1. Preparing and implementing a written abatement project monitoring plan for removals.
2. Directing, coordinating, and approving all activities of air monitors under their supervision.
3. Ensure that ambient (background/daily) air sample results are onsite.
4. Personally, inspect individually permitted asbestos removals.
5. Prepare a written, signed and dated report documenting all site visits made to the removal project, any visual inspections, and all ambient (background/daily) and clearance air sampling conducted.

D. The asbestos air monitor shall be accredited by the North Carolina Department of Health and Human Services.

E. The contractor will be responsible for all costs to complete OSHA compliance monitoring for their own personnel.

2.0 DESCRIPTION OF THE WORK

A. This section describes asbestos daily and clearance monitoring required and sampling that will be performed by S&ME. This is not to be included in the Contractor's Contract Sum. A North Carolina accredited air monitoring firm, provided by the building owner, will conduct the asbestos daily and clearance air monitoring for asbestos.

B. Contractor must conduct OSHA compliance air monitoring throughout the course of the project for various types of materials including asbestos, dust, etc. at their cost.

C. S&ME will perform the necessary monitoring, inspection, testing and other support services of existing areas and systems affected by the environmental remediation/demolition work to ensure that campus employees and visitors will not be adversely impacted and that the environmental work proceeds in accordance with these specifications. At the end of the project, they will ensure the abated areas or abated building have been successfully decontaminated. The work of S&ME in no way relieves the environmental contractor from his responsibility to perform his work in accordance with contract documents, to perform continuous inspections, monitoring, and testing for the safety of his employees, and to perform other such services as specified in this section.

D. The cost of the IH consultant and his services, paid by the building owner and/or the building owner's representative will only cover what is considered usually circumstances. If additional work is caused

by the actions or work practices of the remediation contractor or if additional visuals are required due to the work practices of the remediation contractor, then:

1. Prior to contractor/s final payment and release, the contractor will pay all costs associated with repeated final visual inspections and additional sample testing, if applicable.
2. Repeated final visual inspections and clearance testing is defined as more than one final visual inspection (requested by the project supervisor) and one set of Final Clearance Samples per work area.
3. If the contractor requests Transmission Electron (TEM) Microscopy testing (outside of the regulatory requirements), the contractor will endure the cost.
4. If the contractor requests any type of monitoring or sampling that is outside of the scope outlined, it will be at the sole cost of the contractor.

E. Contractor is responsible for the cost of utilizing S&ME's IH for weekend, holiday work, overtime hours and/or holidays, unless permission the Building Owner or Building Owner's Representative has approved the additional cost.

F. Coordination of hours exceeding the eight-hour daily shift or five-day workweek (40 hours) must be coordinated with the Project Manager 24 hours in advance. Coordination of holiday hours must be coordinated with the Project Manager at least 48 hours in advance.

3.0 ASBESTOS STOP WORK ACTION

A. If asbestos fibers counted by S&ME's IH during abatement work, outside (or inside based on appropriate respiratory protection for workers) the work area utilizing NIOSH 7400 Method exceed the specified respective limits, then contractor shall stop work. Asbestos contractor may request confirmation of high air monitoring results by analysis of samples with TEM. Request must be in writing and submitted to S&ME. Cost for the confirmation of results will be paid by the contractor for both the collection and analysis of samples and for the time delay that may result from this confirmation.

4.0 BACKGROUND AND DAILY AREA AIR MONITORING:

A. Air sampling will be conducted by S&ME prior to asbestos abatement to determine background fiber levels in the work area. Background air samples will be conducted using Phase Contrast Microscopy.

B. The purpose of S&ME's daily area air monitoring is to evaluate quality, resolve problems, and minimize the potential for the spread of contamination beyond the work area. In addition, the work of S&ME includes performance of the final visual inspection and clearance testing to determine whether a space or a building has been adequately decontaminated. All daily air monitoring is to be completed utilizing Phase Contrast Microscopy (PCM) as specified in the following paragraphs. S&ME's IH will perform the following task:

1. Perform continuous air monitoring, inspection, and testing as indicated on the inside and outside of the work area during actual abatement work to detect any faults in the work/isolation areas and any adverse impact on surrounding regulated or non-regulated areas from work area activities. This includes continuous monitoring at critical barriers where employees of other companies may be working.
   a. Outside the Decontamination unit
   b. Outside the negative air exhausts (where accessible)
   c. Inside the Equipment/Dirty Room of the Decontamination unit.

2. Perform final inspection and testing of decontaminated work/isolation areas or buildings at the conclusion of the abatement and clean-up work to certify compliance with decontamination standard.

C. All data, inspection results, and testing results generated by S&ME's IH will be available to the contractor for information and consideration. Sample results shall be posted within 48 hours of completion of sample collection. Contractor shall provide cooperation and support to S&ME's IH for efficient and smooth performance of their work.

D. Monitoring and inspection results provided by the IH may be used to issue stop removal/work orders to the contractor during abatement work, and to accept or reject an area or a building as decontaminated.

E. This section also sets forth airborne fiber levels both inside and outside the work area as action levels, and describes the action required by the Contractor if an action level is not met or is exceeded.

5.0 STOP ACTION LEVELS:

A. Inside Work Area: Maintain an average airborne count in the equipment room (dirty room) of the decontamination unit less than .05 f/cc. If the fiber counts rise above this figure for any sample taken, revise work procedures to lower fiber counts. If the Time Weighted Average (TWA) fiber count for any work shift or 8-hour period exceeds the PEL Level (.1f/cc), stop all work except corrective action, leave negative pressure differential and air circulation system in operation, and notify S&ME's Representative. After correcting cause of high fiber levels, do not work for 24 hours unless otherwise authorized, verbally or in writing, by S&ME's Representative.

B. Outside Work Area: If any air sample taken outside of the Work Area exceeds 0.01 f/cc or the base line established by background air monitoring, immediately and automatically stop all work except corrective action. S&ME's Representative will determine the source of the high reading and notify the Contractor either verbally or in writing.

C. If the high monitoring results are the result of failure of Work/Isolation Area separation measures, initiate the following actions:
    1. Immediately erect new critical barriers to isolate the affected area from the balance of the building. Erect Critical Barriers at the next existing structural isolation of the involved space (e.g. wall, ceiling, and floor).
    2. Decontaminate the affected area in accordance with Project Decontamination Procedures.
    3. Require that respiratory protection as set forth in Respiratory Protection be worn in affected area until area is cleared for re-occupancy in accordance with Final Clearance Monitoring.
    4. Leave Critical Barriers in place until completion of work and ensure that the operation of the negative pressure differential system in the Work/Isolation Area results in a flow of air from the affected area into the existing Work Area.
    5. If the exit from the clean room of the personnel decontamination unit enters the affected area, establish a separate decontamination facility consisting of a Shower Room and Changing Room.
    6. After Certification of Visual Inspection in the Work/Isolation Area, remove critical barriers separating the work area from the affected area. Final air samples will be taken within the entire area as set forth in Final Clearance Monitoring.

D. If the high reading was the result of other causes, initiate corrective action as determined by S&ME's Representative.

6. VISUAL INSPECTION:

A. Final Visual Clearance will not begin until requested by the General Superintendent of the project.

1. Final visual clearance cannot begin until all air monitoring data represents that the Asbestos Abatement Work Area airborne asbestos structure concentrations have been reduced to the level specified.
2. The work area is clear of all environmental waste containers.
3. Sufficient light (as outlined in previous sections) is still in place for S&ME.
4. Access to all surfaces is made available to S&ME (ladders, scaffold's etc.)

B. Only after the work area has passed a thorough visual inspection and successful completion of the visual has been certified by the S&ME IH, can the area be sprayed with lock-down (encapsulant). The Environmental/Demolition Contractor will provide at a minimum a Supervisor to accompany the IH during the visual inspection. A visual inspection of the material being removed from each work area must be passed prior to the final air clearance being collected from the work area where there has been a contaminant remediated.

C. VISUAL INSPECTION OF THE CRAWLSPACE: The onsite IH shall conduct a visual inspection of the crawlspace with a strong flashlight, illuminated crawlspace, a screwdriver or other pointed tool. The IH shall sift through any remaining loose dirt to look for friable material and scratch the surface of the hardpan to find any impacted ACM. No pieces of insulation shall be present on top of the dirt or mixed in with loose soil. Either the supervisor or a worker will accompany the IH during the visual inspection and clean up any identified contamination. Pieces of ACM which have been impacted into the surface of the sub-grade shall be removed to the extend that no such material is visible. If an excessive amount of debris or contaminated soil is visible, terminate the inspection and direct the contractor to reclean the crawlspace.

If previous visible contamination of ACM may be present below the surface of the sub-grade through previous construction activities or water seepage, a sufficient amount of soil shall be removed in those specified locations to demonstrate to the satisfaction of the IH that ACM and contaminated soil have been removed. The visual inspection will be performed in accordance with ASTM Designation E:1368-05, *Standard Practice for Visual Inspection of Asbestos Abatement Projects*.

8.0 CLEARANCE SAMPLING:

A. Air Samples will be collected as follows:
1. After Ninety-Six (96) air changes are completed within the work area, the entire work area is dry, and there are no visible "puddles" of water lying in the crawlspace, a minimum of five air samples will be collected in the crawlspace.

2. Air samples will be collected by S&ME's IH in areas subject to normal air circulation. These areas will be determined by the IH and placed at areas within the work area at the discretion of the IH, as long as they are placed and collected in the means outlined by NC-DHHC and/or EPA AHERA regulations.

9.0 METHOD OF FINAL AIR CLEARANCE ANALYSIS: (PCM or TEM)

A. To determine if the elevated airborne asbestos structure concentration encountered during abatement operations has been reduced to the specified level, the S&ME will secure samples and analyze them according to the following procedures per designated areas.

B. Except for the removal of non-friable materials, component removal of materials, or the surgical removal of less than 160 square feet of surfacing, clearance air samples for interior workspaces that include or have included in the past "public areas" as defined by 10ANCAC 41C.0601 involving friable ACM shall be cleared by TEM Method described in 40 CFR Part 763, Subpart E, Appendix F.

C. Clearance air samples for interior work areas involving non-friable materials, materials removed as components or the surgical removal of less than 160 square feet of surfacing material may be collected and analyzed by the NIOSH 7400 Method for PCM.

D. TEM analysis shall be performed for the clearance testing of the crawlspace. Additionally, soil samples will be collected in the crawlspace upon completion of the visual inspection and analyzed by PLM to ensure all soil contamination has been removed in accordance with Section 02 82 33.1.

E. The analysis method for clearance is determined by NC-DHHC by the size of each abatement project.

F. The analysis method for clearance is determined by AHERA Regulation 40 CFR Part 763 by the size of each abatement project.
    1. PCM samples will be secured as indicated below.
    2. Sampling sensitivity in the tables below refers to:
    3. Detection Limit for PCM analysis as set forth in the analytical method used or Analytical Sensitivity for TEM analysis as set forth in the analytical method used and/or the AHERA regulation.
    4. An accredited air monitor shall conduct, at a minimum, PCM clearance air monitoring at the completion of each NESHAP project. Projects exceeding the project design threshold (3,000 sf, 1,500 lf, and 656 cubic feet of RACM) will require TEM clearance air monitoring.
    5. When conducting clearance air monitoring, the air sampler shall follow the procedures specified in Measuring Airborne Asbestos Following an Abatement Action, EPA Report 600/4-85-049 (1985), which is hereby incorporated by reference, or an equivalent method acceptable to the Department. Procedures shall be summarized and submitted to the facility owner. The air sampler shall report the clearance air monitoring results in writing to the facility owner within five working days following completion of the project and to the Department upon request.
    6. Sampling shall not begin until wet cleaning has been completed and no visible pools of water or condensation remain. Sufficient time shall be allowed for all surfaces to dry. The sampling zone shall be representative of the building occupants' breathing zone.
    7. Sampling shall be conducted only after all interior wall, ceiling, and floor polyethylene sheeting has been removed. Critical barriers and the five-stage decontamination enclosure system shall remain in place until the abated area has passed final clearance.

G. In each homogeneous Work Area after completion of all cleaning work and upon passing a visual inspection, the number of samples (this will be at the discretion of the IH and will be determined by the size of each containment) will be taken and analyzed as follows:
    1. Analysis: Fibers on each filter will be measured using the NIOSH Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods as amended, 1994.
    2. Fibers: referred to in this section include fibers regardless of composition as counted by the phase contrast microscopy method used.
    3. Release Criteria: Decontamination of the work site is complete when every Work Area sample is at or below the Detection Limit above. If any sample is above the Detection Limit, then the decontamination is incomplete and re-cleaning per Project Decontamination is

THIS IS A MINIMUM TABLE FOR CLEARANCE ASBESTOS AIR SAMPLES (DEPENDING ON THE SIZE OF THE WORK AREA, MORE SAMPLES MAY BE COLLECTED AT THE DISCRETION OF THE IH)

Location Sampled	Minimum Number of Samples	Analysis Method Fibers/cc	Analytical Sensitivity (Liters)	Recommended Volume	Rate in Liters per Minute (LPM)
Within each work area and within each area of the Building per each floor	5*	PCM	0.01	1,200*	1-10
Inside the Decontamination Unit (Equipment/Dirty Room)	1 (optional)	PCM	0.01	1,200	1-10
Inside the Decontamination Unit (Clean Room)	1 (optional)	PCM	0.01	1,200	1-10
Directly Outside Each Decontamination unit	1 (optional)	PCM	0.01	1,200	1-10
Outside the Building (if the decontamination Units are inside the building)	2 (optional)	PCM	0.01	1,200	1-10
Work Area Blanks	2	PCM	0.01	0	Open for 30 seconds
Clearance Samples (Inside the work area including 5 inside samples and 3 blanks per AHERA)	5	TEM	0.005 s/cc	>1,200-1,800	8-10

* OR AS REQUIRED BY CONDITIONS

H. Release Criteria: Decontamination of the work site is complete if either of the following two sets of conditions is met:
   1. Each Work Area Sample is below filter background levels
   2. Each Work Area sample volume is greater than 1,199 liters for a 25 mm. sampling cassette and the reading is 0.01 f/cc or less.

I. If these conditions are not met, then the decontamination is incomplete, and the cleaning procedures of Project Decontamination shall be repeated.

10.0 EFFECT ON CONTRACT SUM:
If stop work action levels occur, Contractor is responsible for completing corrective work with no change in the Contract Sum or time requirements, if high airborne fiber counts were caused by Contractor's activities. The Contract Sum and schedule will be adjusted for additional work caused by high airborne fiber counts beyond the Contractor's control. If visual inspection is unsatisfactory or Air Clearance Levels are not met, the Contractor must complete corrective work with no change in

the Contract sum or time requirements. The period for all work, including final clearance and clean-up of the site following results, shall be no later than 5:00 PM on the specified completion date. Contractor shall be responsible for Project Administration and/or S&ME's IH costs on an hourly basis should work continues beyond this time if the delay is the result of the Contractor's activities.

11.0 LABORATORY TESTING AND ANALYTICAL METHODS:

A. PHASE CONTRAST MICROSCOPY AIR SAMPLES (PCM): (Non-friable removal activities such as window caulking and the glovebag method,
Analysis will be performed using the NIOSH 7400 method, as amended in 1994. The services of a testing laboratory may be employed by S&ME to perform laboratory analyses of the air samples. A microscope and technician will be set up at the job site, or samples will be sent overnight daily, so that verbal reports on PCM air samples can be obtained within 24 hours. The Contractor will have access to all air monitoring tests and results within 48 hours.

B. TRANSMISSION ELECTRON MICROSCOPY AIR SAMLES (TEM): (Crawlspace abatement)
Five inside samples, one sealed blank and two field blanks will be collected from a containment where friable removal techniques are employed in accordance with 10A NCAC 41C.0601. Samples shall be submitted to AIHA laboratory with a proficient Analytical Testing Program. Samples results must be available within 48 hours of sample collection and analysis by TEM.

C. SAMPLE VOLUMES:
The number and volume of air samples obtained by S&ME will be in accordance with all regulations and standards governing air monitoring. Additional samples may be taken at S&ME's or S&ME's Representatives discretion. If airborne fiber counts exceed allowed limits, additional samples will be obtained as necessary to monitor fiber levels.

D. SAMPLE CASSETTES: PCM samples will be collected on 25 mm. cassettes, with 0.8 micrometer mixed cellulose ester in a cassette with a conductive extension cowl.

E. CLEARANCE AIR SAMPLES: The number of PCM or TEM samples will be dependent on the size of the containment. A minimum of 5 samples cassettes will be utilized and each sample must pass the 0.01 f/cc for PCM analysis or 70 structures per square millimeter (s/mm^2) for TEM analysis. In containments that have multiple rooms and containments are complicated the air monitor and Project Designer may choose to obtain additional sample cassettes. Each sample cassette must past the 0.01 f/cc for PCM analysis or 70 s/mm^2 for TEM analysis for the work area to meet clearance criteria. All samples must be reported as less than 0.01 f/cc for PCM analysis or less than 70 s/mm^2 for TEM analysis. Any sample reported greater than 0.01 f/cc for PCM analysis or <70 s/mm^2, will be reported as a failed clearance and recleaning will be required of the containment, and the clearance test must be repeated until all clearance samples are reported as less than 0.01 f/cc for PCM analysis or less than 70 s/mm^2.

13.0 WRITTEN REPORTS:
Written reports are posted at the job site daily. The location will be determined by S&ME's IH and Contractor's General Superintendent and will be updated no less each 48 hours or within 24 hours electronically.

14.0 ADDITIONAL TESTING:
The Contractor may conduct his own air monitoring and laboratory testing. If he elects to do this, the cost of such air monitoring and laboratory testing shall be at no additional cost to S&ME or the Building Owner. The air monitoring results generated by the Abatement Contractor or his consultant shall not supersede S&ME’s monitoring results or replace S&ME’s monitoring.

15.0 PERSONNEL MONITORING:

S&ME will NOT be paid by the Building Owner to complete air monitoring to meet Contractor's OSHA requirements for personnel sampling or any other purpose. Contractor is responsible for conducting personnel air monitoring see Section 01562 - Respiratory Protection/Personnel Air Monitoring for following OSHA sampling criteria for all contaminants.

16.0 WINDOW ABATEMENT:

If the windows are scheduled to be refurbished, removal of the windows will include removing the asbestos caulking around the perimeter of the metal frame and the removal of the lead paint. S&ME will conduct a final visual inspection of the window frames to ensure the asbestos caulking and the lead paint have been removed. Wipe samples will be collected from the frames upon completion of the visual inspection to ensure the frames are free of lead.

END OF SECTION

SECTION 02 82 16.1 - NEGATIVE PRESSURE DIFFERENTIAL AND AIR CIRCULATION SYSTEM

1.0 GENERAL

A. This section covers work during the remediation of asbestos, other Hazardous Materials, and the demolition work required to removal asbestos and other hazardous materials. S&ME's onsite Industrial Hygienist shall inspect the negative pressure differential units prior to installation. Any units found to be contaminated will not be permitted inside the buildings. Negative pressure will be required when performing the abatement of the pipe insulation and contaminated soil in the crawlspace.

2.0 NEGATIVE PRESSURE DIFFERENTIAL ISOLATION

A. Separate the building into areas as work/isolation areas with a Negative Pressure Differential system that will cause a movement of air from outside to inside at any breach in the physical isolation of the Work Area.

B. A full negative pressure enclosure shall be established on each floor prior to the removal of any fixtures, piping, conduit, etc. associated with the walls and ceilings. EXCEPTION: The ground floor. Remove the non-asbestos ceiling tiles to assess residual textured ceilings throughout the ground floor. The negative pressure enclosure shall consist of critical barriers and a three-stage decontamination unit attached to each enclosure. Depending upon the size of the containments will dictate the number of negative air machines required to maintain -0.02". The critical barriers will include two layers of a minimum of six mil polyethylene sheeting.

C. Continuously maintain relative pressure in the Work/Isolation Area at an air pressure that is lower than that in any surrounding space in the building, or at any location in the immediate proximity outside of the building envelope. This pressure differential when measured across any physical or critical barrier must equal or exceed a static pressure of -0.02 per column inches of water per OSHA regulations.

D. Accomplish the pressure differential by exhausting a sufficient number of HEPA filtered fan units from the Work/isolation Area. The number of units required will depend on machine characteristics, the seal at barriers, and required air circulation. The number of units will increase with increased make-up air or leaks into the Work/isolation Area. Determine the number of units required for pressure isolation by the following procedure:

1. Establishing the required air circulation in the Work/isolation Area, personnel, and equipment decontamination units.
2. Exhausting a sufficient number of units from the Work/isolation Area to develop the required pressure differential.
3. Maintain sufficient units that allow for four air changes per hour.

3.0 QUALITY ASSURANCE:

A. Monitor pressure differential at locations approved by the Building Owner's Representative or the Owner's IH with a differential pressure meter equipped with a continuous recorder. General Superintendent or Supervisor will mark the strip chart at the beginning and end of each work shift with the date, time, and their initials. The manometer strip shall also be marked if any unusual events affecting the pressure differential occur such as a power loss or a breach of the Work/isolation area isolation barriers. Meters shall be equipped with a warning alarm that will sound if pressure differential drops below -0.02 inches of water. If the differential pressure meters have variable settings, it may be set at -0.02 inches of water. OSHA requires the use of ventilation smoke tubes at the beginning of each shift to test for negative pressure and for the supervisor to document the event. The Building Owner's Representative may require additional pressure differential monitoring around the perimeter of the Work/isolation Area to check the system performance. Contractors will be required to maintain a manometer unit for each negative pressure containment

used during remediation (if more than one containment is active, contractor will provide a manometer for each active containment.)

B. On a weekly basis (if applicable): Submit printout from pressure differential monitoring equipment. Mark printout twice daily with date, time, and initials. Use printout paper that indicates elapsed time in intervals no greater than 4 hours. Indicate on each day's record, times of starting and stopping remediation/demolition work, type of work in progress, breaks for lunch or other purposes, periods of stop work, and filter changes. Cut printout into segments by day, attach to 8 1/2" by 11" paper. Label with project name, contractors name, and date.

4.0 HEPA FILTERED FAN UNITS:

A. Supply the required number of HEPA filtered fan units to the site in accordance with these specifications. Use units that meet the following requirements.

B. Cabinets are to be constructed of durable materials able to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Provide units whose cabinets are:
   1. Factory-sealed to prevent asbestos-containing dust from being released during use, transport, or maintenance.
   2. Arranged to provide access to and replacement of all air filters from intake end.
   3. Mounted on casters or wheels.
   4. Rate capacity of fan according to usable air movement capacity under actual operating conditions.

C. All units are to have new HEPA filters installed prior to placement on project site. If a unit is found to contain a dirty filter(s) the contractor will be required to have new HEPA filter(s) installed immediately or have the unit with the dirty filter(s) removed from the jobsite.

D. Additional HEPA filtered fan units (SCRUBBERS):
Along with the required number of HEPA filtered fan units to be used to maintain negative pressure in the work/isolation area, additional HEPA Filtered fan units may be required to be utilized as scrubber machines to circulate air to reduce air monitoring counts or to help with the reduction of heat in the work area. These machines will meet all standards for the HEPA Filtered fan units as stated in the above section. These units will be placed strategically throughout the work/isolation area to reduce the air counts.

5.0 SAFETY AND WARNING DEVICES:

A. Provide units with the following safety and warning devices:
   1. Electrical (or mechanical) lockout to prevent fan from operating without a HEPA filter.
   2. Automatic shutdown system to stop fan in the event of a rupture in the HEPA filter or blocked air discharge.
   3. Warning lights to indicate normal operation (green), too high a pressure drop across the filters (i.e., filter overloading) (yellow), and too low of a pressure drop (i.e., rupture in HEPA filter or obstructed discharge) (red)
   4. Audible alarm if unit shuts down due to operation of safety systems.
   5. Provide units with electrical components approved by the National Electrical Manufacturers Association (NEMA) and Underwriter's Laboratories (UL). Each unit is to be equipped with overload protection sized for the equipment. The motor, fan, fan housing, and cabinet are to be grounded.

6.0 HEPA FILTERS:

A. Provide units whose final filter is the HEPA type with the filter media folded into closely pleated panels and completely sealed on all edges with a structurally rigid frame. Provide units with a

continuous rubber gasket located between the filter and the filter housing to form a tight seal. Provide HEPA filters that are individually tested and certified by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3 um dioctylphthalate (DOP) particles when tested in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Provide filters that bear a UL586 label to indicate ability to perform under specified conditions. Provide filters that are marked with the name of the manufacturer, serial number, airflow rating, efficiency, and resistance, and the direction of test air flow.

7.0 PREFILTERS:

A. Prefilters that protect the final filter by removing the larger particles are required to prolong the operating life of the HEPA filter. Two stages of prefiltration are required. Provide units with the following prefilters:
   1. First-stage prefilter: low-efficiency type (e.g., for particles 100 um and larger) :
   2. Second-stage (or intermediate) filter: medium efficiency (e.g., effective for particles down to 5 um) :
   3. Provide units with prefilters and intermediate filters installed either on or in the intake grid of the unit and held in place with special housings or clamps. :

B. Contractor will provide sufficient number of prefilters to be changed at a minimum of once a day during prep and fine cleaning work and at a minimum of twice a day during gross removal. This does not limit the actual changing of filters as needed or as observed to be dirty.

8.0 VENT HEPA FILTERED FAN UNITS TO OUTSIDE OF BUILDING:

A. Unless authorized in writing by Owner's Representative all units will be vented to the outside of the building. Mount units to exhaust directly or through disposable ductwork. Use only new ductwork except for sheet metal connections and elbows, use ductwork and fittings of same diameter or larger than discharge connection on fan unit. Use inflatable, disposable plastic ductwork in lengths not greater than 100 feet or use spiral wire-reinforced flex duct in lengths not greater than 50 feet. Arrange exhaust as required to inflate duct to rigidity sufficient to prevent flapping. If direction of discharge from fan unit is not aligned with duct, use sheet metal elbows to change direction. Use six feet of spiral wire reinforced flex duct after direction change.

9.0 CALCULATION FOR AIR CIRCULATION IN THE WORK/ISOLATION AREA FOR VENTED HEPA FAN UNITS

A. This section refers to the introduction of outside air to the Work/isolation Area. Air circulation in the Work/isolation Area is a minimum requirement intended to help maintain airborne fiber counts at a level that does not significantly challenge the Work/isolation Area isolation measures. The Contractor may also use this air circulation as part of the engineering controls in his worker protection program.

B. Provide an operational air circulation system supplying a minimum of the following air circulation rate: 4 air changes per hour to achieve required air circulation according to the following procedure:

C. Determine the volume in cubic feet of the Work/isolation area by multiplying floor area by ceiling height. Determine total air circulation requirement in cubic feet per minute (CFM) for the Work/isolation Area by dividing this volume by the air change rate and multiplying by 60.

Air Circulation Required in Cubic Feet of Air per Minute (CFM) =

Volume of Work/isolation Area (cu. ft.) X Number of air changes per hour
60 minutes per hour)

1. Divide the air circulation requirement (CFM) above by capacity of HEPA filtered fan unit(s) used. Capacity of a unit for purposes of this section is the capacity in cubic feet per minute

with fully loaded filters (pressure differential which causes loaded filter warning light to come on) in the machine's labeled operating characteristics or 50% of the manufacturer's rated capacity for the unit. The capacity of the combined units shall at least be capable of maintaining a negative pressure differential of 0.02 inches of water around the entire perimeter of the Work/isolation Area.

2. Provide a minimum of 2 additional units as backups in case of equipment failure or machine shutdown for filter changing.

D. Contractor is responsible for calculating the correct number of units per containment and for providing enough units during the removal process to ensure negative pressure.

E. Location of HEPA Filtered Fan Units: Locate fan unit(s) so that makeup air enters Work/isolation Area primarily through decontamination facilities and traverses Work/isolation Area as much as possible. This may be accomplished by positioning the HEPA filtered fan unit(s) at a maximum distance from the worker access opening or other makeup air sources. The location of these units must be designated on drawings submitted by the Contractor to the Building Owner's Representative prior to the Pre-Construction Meeting. Place End of the Fan Unit at intake duct or its exhaust duct through an opening in the plastic barrier or wall covering. Seal plastic around the unit or duct with tape.

F. Decontamination Units: Arrange Work/isolation Area and decontamination units so that the majority of make up air comes through the Decontamination Units. Use only personnel or equipment Decontamination Unit at any one time and seal the other so that make up air passes through unit in use. Personnel and equipment Decontamination Units may be used at the same time only if prior permission is obtained from the Building Owner's Representative or the Owner's IH.

10.0 DEMONSTRATION OF THE PRESSURE DIFFERENTIAL AND AIR CIRCULATION SYSTEM:

A. Testing the System: Test pressure differential system before any asbestos-containing material is wetted or removed. After the Work/isolation Area has been prepared, the decontamination facility set up, and the fan unit(s) installed, start the unit(s) (one at a time). Demonstrate operation and testing of pressure differential system to Owner's Representative and/or the Project Administrator before start of work/isolation by performing smoke test to check for leaks and breaches as outlined in OSHA CFR 1926.1101 (i)(B)(1). Smoke tests are to be completed at the beginning of each shift and documented on the superintendent’s daily logs per OSHA regulations.

11.0 USE OF SYSTEM DURING REMEDIATION OPERATIONS:

A. After the pressure differential system has been tested and approved by the Building Owner’s IH and remediation/demolition work has begun, run units continuously to maintain a constant pressure differential and air circulation until decontamination of the Work/isolation Area is complete and final clearance air monitoring results have been obtained. Do not turn off fan units at the end of the work shift or when remediation/demolition operations temporarily stop or during final clearance air monitoring.

B. Do not shut down air pressure differential system during encapsulating procedures, unless approved by applicable regulatory authorities and authorized by the Owner's Representative in writing. Supply sufficient pre-filters to allow frequent changes (frequent changes can be interpreted, as when the exterior pre-filter is visibly dirty it needs to be changed).

C. Start remediation/demolition work at a location farthest from the fan units and proceed toward them. If an electric power failure occurs, immediately stop all remediation/demolition work and do not resume until power is restored and fan units are operating again. Document the date and time of the power failure on the pressure differential monitor strip chart and notify the Building Owner's Representative and/or the Owner's IH immediately.

D. Where the contractor cannot produce a negative exposure assessment, or where exposure monitoring shows that a PEL is exceeded, the contractor shall ventilate the regulated area to move contaminated air away from the breathing zone of employees toward a HEPA filtration or collection device.

E. After the pressure differential system has been tested and approved by the Building Owner's IH and remediation/demolition work has begun, run units continuously to maintain a constant pressure differential and air circulation until decontamination of the Work/isolation Area is complete and final clearance air monitoring results have been obtained. Do not turn off fan units at the end of the work shift or when remediation/demolition operations temporarily stop or during final clearance air monitoring.

F. Do not shut down air pressure differential system during encapsulating procedures, unless approved by applicable regulatory authorities and authorized by the Owner's Representative in writing. Supply sufficient pre-filters to allow frequent changes (frequent changes can be interpreted, as when the exterior pre-filter is visibly dirty it needs to be changed).

G. Start remediation/demolition work at a location farthest from the fan units and proceed toward them. If an electric power failure occurs, immediately stop all remediation/demolition work and do not resume until power is restored and fan units are operating again. Document the date and time of the power failure on the pressure differential monitor strip chart and notify the Building Owner's Representative and/or the Owner's IH immediately.

H. Where the contractor cannot produce a negative exposure assessment, or where exposure monitoring shows that a PEL is exceeded, the contractor shall ventilate the regulated area to move contaminated air away from the breathing zone of employees toward a HEPA filtration or collection device.

12.0 DISMANTLING THE SYSTEM:

A. When a final inspection and the results of final air tests indicate that the area has been decontaminated, fan units may be removed from the Work/isolation Area. Before removal from the Work/isolation Area, remove and properly dispose of pre-filter, decontaminate exterior of machine and seal intake to the machine with 6-mil polyethylene to prevent environmental contamination from the filters.

END OF SECTION

SECTION 02 82 16.2 - TEMPORARY ENCLOSURES

1.0 GENERAL

A. This section covers work during the remediation of asbestos, other Hazardous Materials, and the demolition work required to removal asbestos and other hazardous materials.

2.0 DESCRIPTION OF WORK

A. The establishment of work/isolation areas from the outside environmental. Work in the section is to be carried out sequentially. Complete each activity before proceeding to the next.

B. Asbestos Abatement of the building prior to demolition.

3.0 REGULATED AREA:

A. Prior to the onset of work, the contractor shall coordinate with the Owner and identify locations of all shutoff valves (water, gas, oxygen etc.), electrical panels, fire alarm panels, drains, ducts, etc. inside or outside the building that control services extending to the building. The contractor shall determine if the mechanisms also control services to other buildings and the impact on existing building services. The contractor shall be responsible for hiring any tradesmen to make disconnects, to cap, modify and/or reroute services as required by the project. All work related to service modification shall comply with applicable building codes and use materials compatible with existing systems. Where services are capped, the termination shall occur at the perimeter of the building's exterior envelope, unless otherwise approved by the Owner and Designer, and leave sufficient existing material so that new services can be reconnected. The contractor may have to perform some preliminary activities in the work area so the trades can safely perform the work.

B. The contractor shall be responsible for the collection and proper disposal of all refrigerants and compressor oils encountered in the building. This may include but may not be limited to air handling equipment and coolers.

C. The Regulated area is the location where environmental remediation work occurs. All class I, II, and III asbestos work as defined in OSHA CFR 1926.1101 (b) shall be conducted within regulated areas. The regulated area shall be demarcated in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to airborne concentrations of asbestos.

D. The Critical barriers and the negative pressure enclosure shall be demarcated as regulated area. Signs and barrier tape shall be provided and displayed. Access to the regulated area shall be limited to authorized persons and to persons authorized by the regulations to enter the regulated area. Signage should be in English and Spanish.

E. Prohibited activities within the regulated work area include but are not limited to, no eating, drinking, smoking, chewing of tobacco or gum, or applying of cosmetics. The competent person shall ensure that all asbestos work performed within a regulated work area is supervised by a competent person (defined in North Carolina as an accredited Supervisor).

4.0 WORK/ISOLATION AREA:

A. The Work/Isolation area that is located within the regulated area is a variable of the extent of work of the Contract. It may be a portion of a room, a single room, or a complex of rooms. A "Work/Isolation Area" is considered contaminated during the work and must be separated from the balance of the building and decontaminated at the completion of the asbestos-control work.

B. Completely separate the Work/Isolation Area from other parts of the building to prevent asbestos-containing/contaminated dust or debris from passing beyond the work/isolated area. Should the area beyond the Work/Isolation Area(s) become contaminated with asbestos-containing/contaminated dust or debris because of the work, the contractor shall clean those areas in

accordance with the specifications. Perform all such required cleaning or decontamination at no additional cost to owner.

C. Place all tools, scaffolding, staging, etc. necessary for the work in the area to be separated prior to completion of Work/Isolation Area separation.

D. The crawlspace shall include the installation of critical barriers on all openings associated with the walls and subfloor. A three-stage decontamination unit shall be constructed at the entrance to the crawlspace. The crawlspace will include the removal of contaminated soil; therefore, two layers of polyethylene sheeting on top of the soil will not be required.

E. In accordance with OSHA 29 CFR 1926.56, Illumination, a minimum of 10-foot candles of illumination will be required in the crawlspace. S&ME's onsite IH will inspect the containments prior to the start of the project to ensure compliance with the standard.

F. During the removal of the paint from the windows, if scheduled to be refurbished, shall be stripped onsite. If the contractor choses to refurbish the windows remotely, approval will be required by UNC-EHS and the Project Designer. Two layers of drop cloth comprised of 6 mil polyethylene sheeting shall be placed beneath the windows secured to the exterior wall up 18 inches and extend out 6 feet from the wall. The work area shall include barrier tape, OSHA Danger Signage, and decontamination area equipped with a HEPA vacuum and water for employees to don and doff PPE. The tan paint on the exterior and the white paint on the interior windows shall be removed in accordance with OSHA 29 CFR 1926.62. The contractor shall designate an area to perform the paint stabilization of the window frames. Demarcate the area with barrier tape and signage which indicates lead hazards. Utilizing manual methods, remove the residual paint from the frames. Once the paint is removed, utilize disposable wipes to clean the frame, only utilizing the wipe to conduct one pass over the frame and discard as lead-contaminated debris. Any liquid waste generated during the removal of the paint, including the paint chips shall be collected and tested using the Toxicity Characteristic Leaching Procedure (TCLP) and discarded appropriately. A TCLP sample shall be collected by the Contractor, and the results must be reported to the Hazardous Waste Manager with EHS, 919-962-5509, prior to disposal.

G. The regulated area utilized during the removal of the asbestos caulk and lead paint on the window frames shall include a decontamination area with soap and water. Each employee entering and exiting the regulated area shall don PPE including disposable overalls, gloves, and safety glasses. Upon exiting the regulated area, each employee shall remove their PPE utilizing a HEPA vacuum to clean their disposable coveralls prior to doffing the PPE in the designated decontamination area. Once the employee removes their disposable suit, remove the gloves and proceed to the hand washing station and thoroughly wash hands with soap and water. The water shall be captured and collected for waste characterization. The employee shall not reenter the regulated area without donning the properly PPE.

H. Lead-containing paint and lead-based paint were identified. The contractor shall assume lead-containing paint is present due to the 1927 date of construction. The contractor is responsible for OSHA compliance with 29 CFR 1926.62-OSHA Lead Construction Standard. This is strictly an OSHA concern for the Contractor and should not impact the price for abatement. In addition, the contractor is responsible for any requirement of TCLP sampling for disposal purposes.

IT IS CONTRACTOR'S RESPONSIBILITY TO ENSURE ALL POWER TO THE BUILDING HAS BEEN DISCONNECTED to the building(s) where work is being completed.

1.0 Lockout, cut–off, and properly cap all systems necessary, (i.e. steam lines, condensate, etc.) prior to the removal of asbestos containing material. Where existing piping is removed from piping which will remain in service, all termination points remaining on the active piping must be adequately sealed utilizing one of the following options:

5.0 EMERGENCY EXITS:

A. Provide emergency exits and emergency lighting as set forth. At each existing exit door from the Work Area provide the following means for emergency exiting:
   1. Arrange exit door so that it is secure from outside the Work area but permits exiting from the Work Area.
   2. Provide a visible sign at each exit, written in appropriate language(s).
   3. Provide battery-operated emergency lighting that can be manually switched on or will switch on automatically in the event of a power failure.

6.0 CONTROL ACCESS:

A. Submit to Owner's Representative a list of doors and other openings that must be secured to Work/Isolation Area. Include on the list a notation if door or opening is in an indicated exit route.

   1. Locked Access: Arrange Work/Isolation Area so that the only access into area is through lockable doors to personnel and equipment decontamination units. Use existing locksets whenever possible and arrange for obtaining the keys from the Building Owner's Representative at the Pre-Construction meeting. Provide additional locksets and/or padlocks as needed and provide one key for each lock to Building Owner, Owner's Representative, and maintain one key in project office area (3 total). It will be the responsibility of the Environmental Contractor to ensure that the work/isolation areas of the building are secured at all times.

   2. Visual Barrier: Where the Work Area is immediately adjacent to or within view of occupied areas, provide a visual barrier of opaque polyethylene sheeting at least 6 mil in thickness so that the work procedures are not visible to building occupants. Where this visual barrier would block natural light, substitute frosted or woven rip-stop sheet plastic in locations approved by the Owner's Representative. However, allow for viewing ports of plexi-glass for the Building Owner, inspectors and his representatives, measuring 24 inches by 24 inches in an external wall of the contained work area. A viewing port needs to be placed at each end of the containment.

   3. Provide Warning Signs at each access to Regulated Area on doors and/or critical barriers. Post an approximately 20 inch by 14 inch manufactured caution sign displaying the following legend with letter sizes and styles of a visibility required by OSHA 29 CFR 1926.1101:
      LEGEND: After June 1, 2016

      DANGER

      ASBESTOS

      MAY CAUSE CANCER
      CAUSES DAMAGE TO LUNGS
      AUTHORIZED PERSONAL ONLY

      WEAR RESPIRATORY PROTECTION
      AND
      PROTECTIVE CLOTHING IN THIS AREA

      Provide spacing between respective lines at least equal to the height of the respective upper line.

7.0 CRITICAL BARRIER REQUIREMENTS:

Prior to erecting critical barriers, conduct a pre-cleaning of each affected area utilizing personal protective equipment including a minimum of half mask air purifying respirator, double disposable suits, (unless a negative exposure assessment can be provided) and hard hat. Use a HEPA vacuum immediately adjacent to any inaccessible housings or ductwork that must be cleaned.

A. The onsite Industrial Hygienist and Supervisor will conduct an initial visual inspection of the affected areas prior to the erection of the critical barriers.

1. Provide Sheet Polyethylene at least two (2) layers of 6-mil in thickness and put in place utilizing duct tape. No spray adhesive may be used that comes in contact with the existing wall or floor surface.

2. Repair of Damaged Polyethylene Sheeting: Remove and replace polyethylene sheeting that has been damaged by removal operations or where seal has failed and may allow water to seep between layers. Remove affected sheeting and wipe down entire area. Install new sheet plastic only when area is completely dry. Critical barriers are to be inspected at the beginning of each shift, periodically throughout the shift, and again at the end of each shift. All inspections and the name of the worker who completed the task are to be documented on the supervisor’s daily logs.

B. Complete all of the following procedures in erecting the critical barriers:

1. Completely Separate Work/Isolation Areas from other portions of the building, and the outside by closing all openings with sheet plastic barriers. The following critical barriers shall be erected as defined. If the environmental/demolition contractor prefers alternate methods of containing the Work/Isolation Area, these alternate methods may be submitted to the Owner's Representative for approval. Submittal of alternate methods must provide, at a minimum, the same level of protection for the building and its occupants as specified in this contract document. If such alternate methods are submitted, they must comply with all existing regulations for Federal and State agencies. The contractor cannot assume that the alternate methods will be accepted; all alternatives must be reviewed and the contractor given written approval of these alternate methods before altered work practices can be initiated.

2. Doorways, windows, drains, and miscellaneous openings is to be sealed with a minimum of two (2) layers of polyethylene sheeting at least 6 mil in thickness taped securely or spray glued in place. Maintain seal until all work including Project Decontamination is completed.

8.0 PROVIDE NEGATIVE PRESSURE DIFFERENTIAL SYSTEM PER SECTION 01513.

A. PREPARE WORK/ISOLATION AREA (CONTAINMENT):
1. The environmental/demolition contractor is responsible for complete removal of all asbestos containing/contaminated materials, PCB light fixtures and other environmental contaminates found within the footprint and other designated areas along with providing the skills and/or necessary labor to complete the work outlined in this specification.

2. All sequencing of work must be approved once the apparent low bidder’s job specific plan is presented, this plan will include the chronological sequences of the work.

3. Any other furniture or debris left in place will be considered contaminated and disposed as asbestos waste by the environmental contractor. The contractor is responsible for the removal and packaging of all fluorescent light tubes, and the PCB ballasts within the light fixture located within the building. Contractor can recycle any ballasts. If recycling of waste is not feasible the contractor is responsible for packaging and disposal of the material through their designated hazardous waste removal contractor.

4. Ladders: If ladders are to be used to provide access, ensure that the ladders are of fiberglass materials and conform to all OSHA regulations. Scaffolding utilized in the Sanctuary shall be erected in accordance with OSHA 29 CFR 1926.451.

5. Remove all electrical and mechanical items, such as light fixtures, registers, escutcheon plates, mercury thermostats, etc. Any item that will disturb asbestos must not be removed until full isolation and negative pressure is complete. All items that contain contaminants must be disposed of as regulated by the contaminate.

9.0 STOP WORK:

A. If the Critical barrier falls or are breached in any manner stop work immediately. Do not start work until authorized in writing by the Owner's Representative.

B. Extension of Work/Isolation Area:
If the Critical Barrier is breached in any manner that could allow the passage of asbestos debris or airborne fibers, notify the Building Owner's Representative and the Owner's IH. Upon their instruction, add the affected area to the Work/Isolation Area, enclose it as required by this Section of the specification, and decontaminate it as described in Section 01711 Project Decontamination.

10.0 ALTERNATE METHODS OF ENCLOSURE:

A. Alternate methods of containing the Work/Isolation Area may be submitted to the NC-DHHS State for approval. Do not proceed with any such method(s) without prior written approval of the Owner's Representative. If such alternate method is submitted, it must comply with all existing regulations for Federal and State agencies.

11.0 QUALITY ASSURANCE:

A. Contact the Building Owner's Representative or the Owner's IH when work in this section is completed so that the Pre-Containment Checklist provided in Appendix A can be executed. Perform corrective action as instructed by the Building Owner's Representative or the Owner's IH. Obtain a copy of the Pre-Containment Checklist signed by the Building Owner's Representative or the Owner's IH indicating that all items on the checklist have been satisfactorily completed before proceeding with the Work.

END OF SECTION

SECTION 02 82 17 - DECONTAMINATION UNITS

1.0 GENERAL

2.0 DESCRIPTION OF WORK:

A. Provide separate Personnel and Equipment Decontamination facilities for each work/isolation area. Require that the Personnel Decontamination Unit be the only means of entrance and exit for the Work/Isolation Area. Require that all materials exit the Work/Isolation Area through the Equipment Decontamination Unit. The personnel and equipment decontamination units shall be configured within the interior of the building. Avoid placement of the decontamination unit to the exterior of the building. Because the crawlspace is scheduled to be abated, access into the crawlspace is limited to one entry; the decontamination unit will also serve as the waste loadout.

B. Locked Access: Arrange Work/Isolation Area so that the only access into Work/Isolation Area is through lockable doors at the personnel and equipment decontamination units. Provide a wooden door access with a lock for all decontamination units placed outside the buildings. Use existing locksets whenever possible and arrange for obtaining the keys from the Building Owner's Representative at the Pre-Construction meeting. If existing locksets are unavailable, provide additional locksets and/or padlocks as needed and provide one key for each door to the Building Owner, the Owner's Representative or the Owner's IH, and maintain one key in project office area (3 total).

3.0 CONSTRUCTION OF THE DECONTAMINATION UNITS:

A. Walls and Ceiling: Construct airtight walls and ceiling using opaque polyethylene sheeting, at least 6 mil in thickness. Attach to existing building components or a temporary, but study wooden or PVC framework.

B. Floors: Use 2 layers (minimum) of 6 mil polyethylene sheeting to cover floors in all areas of the Decontamination Units. Use only clear plastic to cover floors.

C. Doors: Follow a three overlapping door configuration that will maintain negative pressure in the Work/Isolation Area. Put arrows on the doors to indicate direction of overlap and/or travel. Provide a minimum of six feet (6') between entrance and exit of any room. Provide a minimum of three feet (3') between doors to airlocks.

D. Electrical: Provide sub panel to accommodate all removal equipment. Wire the power sub panel directly from a building electrical panel. Connect all electrical branch circuits in Decontamination unit and particularly any pumps in shower room to a ground-fault circuit protection device.

E. Filters: Provide cascaded filter units on drain lines from showers or any other water source carrying asbestos-contaminated water from the Work/Isolation Area. Provide units with disposable filter elements including a Primary Filter that passes particles 20 microns or less and a Secondary Filter that passes particles 5 microns and smaller. Connect so that discharged water passes through primary filter and output of primary filter passes through secondary filter. Discharge all filtered water to a sanitary sewer system.

F. Hose Bib: Provide heavy bronze angle type with wheel handle, vacuum breaker, and 3/4" National Standard male hose outlet.

G. Elastomeric membrane: Provide uniform flat sheets of flexible sheet roofing material fabricated from EPDM (ethylene propylenedienemonomers) or Neoprene (polychloroprene), in a nominal 45-mil thickness.

H. Lumber: If used, provide kiln-dried lumber of any grade or species.

I. Sump Pump: Unless written permission is obtained from the Building Owner's Representative, provide totally submersible waterproof sump pump with integral float switch. Provide unit sized to pump 2 times the flow capacity of all showers or hoses supplying water to the sump, through the filters specified herein when they are loaded to the extent that replacement is required. Provide unit capable of pumping debris, sand, plaster or other materials washed off during decontamination procedures without damage to mechanism of pump. Adjust float switch so that a minimum of 3" remains between top of liquid and top of sump pan.

J. Wastewater filtration device: Provide 20-micron and 5-micron wastewater filters in line to drain or wastewater storage. Change filters daily or more often if necessary. Locate filters inside shower unit so that water lost during filter changes is caught by shower pan. Provide hose bib.

4.0 PERSONNEL DECONTAMINATION UNIT:

A. Provide a Personnel Decontamination Unit consisting of a serial arrangement of connected rooms or spaces, Changing Room, Shower Room, and Equipment Room. Require all persons without exception to pass through this Decontamination Unit for entry into and exiting from the Work/Isolation Area for any purpose. Do not allow parallel routes for entry or exit. Do not remove equipment or materials through Personnel Decontamination Unit unless there is not sufficient room to provide a waste load out area. Provide temporary lighting within Decontamination Units as necessary to reach a lighting level of 100 watts. Follow 29 CFR 1910.141, Sanitation, for specific supplies, i.e. soap, towels, hot and cold water.

B. Changing Room (clean room): Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing. Construct using polyethylene sheeting, at least 6-mil in thickness, to provide an airtight seal between the Changing Room and the rest of the building. Locate so that access to Work/Isolation Area from Changing Room is through Shower Room. Separate Changing Room from the building by 3-sheet plastic flapped doorway, a doorway equipped with a floating HEPA filter, or a lockable door. Require workers to remove all street clothes in this room, dress in clean, disposable coveralls, and don respiratory protection equipment. Do not allow asbestos-contaminated items to enter this room. Require Workers to enter this room either from outside the structure dressed in street clothes, or from the showers. An existing room may be utilized as the Changing Room if it is suitably located and of a configuration whereby workers may enter the Changing Room directly from the Shower Room. Protect all surfaces of room with sheet plastic as set forth in Section 01526 Temporary Enclosures. Authorization for this must be obtained from the Owner's Representative in writing prior to start of construction. Maintain floor of changing room dry and clean at all times. Do not allow overflow water from shower to wet floor in changing room. Damp wipe all surfaces twice after each shift change with a disinfectant solution. Provide posted information for all emergency phone numbers and procedures. Provide storage for each employee for clothing and personal items.

C. Shower Room: Provide a completely watertight operational shower to be used for transit by cleanly dressed workers heading for the Work/Isolation Area from the Changing Room, or for showering by workers headed out of the Work/Isolation Area after undressing in the Equipment Room. Construct room by providing a shower pan and 2 shower walls in a configuration that will cause water running down walls to drip into pan. Provide one-piece waterproof shower pan 4' x 8' by 6" deep. Fabricate from seamless fiberglass minimum 1/16" thick reinforced with wood, 18 ga. stainless or galvanized steel with welded seams, copper or lead with soldered seams, or a seamless liner of minimum 60 mil thick elastomeric membrane. Install a freely draining wooden floor in shower pan at elevation of top of pan. Provide walls fabricated from rigid, impervious, waterproof material, either corrugated fiberglass roofing or equivalent approved by the Building Owner's Representative. Structurally support as necessary for stability. Separate this room from the rest of the building with airtight walls fabricated of 6-mil polyethylene. Separate this room from the Changing Room and Airlock with airtight walls fabricated of 6-mil polyethylene. Provide splash proof entrances to Changing Room and Airlock with doors. Provide a factory-made showerhead producing a spray of water that can be adjusted for spray size and intensity. Feed shower with water mixed from hot and cold supply lines.

Arrange so that control of water temperature, flow rate, and shut off is from inside shower without outside aid. Provide a soap dish and a continuously adequate supply of soap and maintain in sanitary condition. Arrange so that water from showering does not splash into the Changing or Equipment Rooms. Arrange water shut off and drain pump operation controls so that a single individual can shower without assistance from either inside or outside of the Work/Isolation Area. Provide flexible hose shower head. Pump wastewater to drain or to storage for use in amended water. If pumped to drain, provide 20 micron and 5 micron wastewater filters in line to drain or wastewater storage. Change filters daily or more often if necessary. Locate filters inside shower unit so that water lost during filter changes is caught by shower pan. Provide hose bib.

D. Equipment Room (contaminated area): Require work equipment, footwear, and additional contaminated work clothing to be left here. This is a change and transit area for workers. Separate this room from the Work/Isolation Area by a 3-sheet plastic flapped doorway, a closable doorway, or a solid door connected to the Equipment Room doorway in such a way that both doors are never open at the same time. Separate this room from the rest of the building with airtight walls fabricated of 6-mil polyethylene. Separate this room from the Shower Room and Work/Isolation Area with airtight walls fabricated of 6-mil polyethylene. Provide a drop cloth layer of sheet plastic on floor in the Equipment Room for every shift change expected. Roll drop cloth layer of plastic from Equipment Room into Work/Isolation Area after each shift change. Replace before next shift change. Provide a minimum of two (2) layers of plastic at all times. Use only clear plastic to cover floors.

E. Although not required in North Carolina, it is suggested that separating airlocks are used between each of the above listed rooms.

F. A remote decontamination unit shall be constructed in close proximity to the bathroom areas during the removal of the pipe insulation utilizing the glovebag method.

G. Work/Isolation Area: Separate Work/Isolation Area from the Equipment Room by polyethylene barriers. Damp wipe clean all surfaces after each shift change. Provide one additional floor layer of 6-mil polyethylene per shift change and remove contaminated layer after each shift.

H. Decontamination Sequence: Require that all workers adhere to the following sequence when entering or leaving the Work/Isolation Area.

I. Entering Work/Isolation Area: Worker enters Changing Room and removes street clothing, puts on clean disposable overalls and respirator, and passes through the Shower Room into the Equipment Room. Any additional clothing and equipment left in Equipment Room needed by the worker are put on in the Equipment Room. Worker proceeds to Work/Isolation Area.

J. Exiting Work/Isolation Area: Before leaving the Work/Isolation Area, require the worker to remove all gross contamination and debris from overalls and feet. The worker then proceeds to the Equipment Room and removes all clothing except respiratory protection equipment and nylon swimsuit, if worn. Extra work clothing such as boots, hard hats, goggles, and gloves are to be stored in contaminated end of the Equipment Room. Disposable coveralls and disposable undergarments are placed in a bag for disposal with other material.

K. Require that Decontamination procedures found in Section 01560 be followed by all individuals leaving the Work/Isolation Area. After showering, the worker moves to the Changing Room and dresses in either new coveralls for another entry or street clothes if leaving.

5.0 EQUIPMENT DECONTAMINATION UNIT:

A. If sufficient room, provide an Equipment Decontamination Unit consisting of a serial arrangement of rooms, Clean Room, Holding Room, airlock, Washroom separated for removal of equipment and material from Work/Isolation Area. Do not allow personnel to enter or exit Work/Isolation Area through Equipment Decontamination Unit. Arrange with airlocks between rooms as required below.

B. Wash Down Station: Provide an enclosed Shower Unit located in Work/Isolation Area just outside Washroom or an alternate location approved in writing by the Building Owner's Representative as an equipment, bag, and container cleaning station. Fabricate waterproof floor extending 6' - 0" beyond Wash Down station in all directions. Install seamless waterproof membrane over area and extend over curbs on all four sides. Form curbs from 2" x 4" lumber laid on the flat. Waterproof membrane is to be fabricated from minimum 10-mil polyethylene or elastomeric membrane. Do not allow water to collect on waterproof membrane. Remove continuously with a wet vacuum or mops.

C. Wash Down Shower Unit: Provide leak tight shower enclosure with integrated drain pan fabricated from fiberglass or other durable waterproof material, approximately 3' x 3' square with minimum 6' high sides and back. Structurally support as necessary for stability. Equip with hose bib, as specified in this section, mounted at approximately 4'-0" above drain pan. Connect drain to a reservoir, pump water from reservoir through filters to a drain or store and use for amended water. Mount filters inside shower stall on back wall beneath hose bib.

D. Washroom: Provide washroom for cleaning of bagged or containerized asbestos-containing waste materials passed from the Work/Isolation Area. Construct washroom of nominal 2" x wood framing and opaque polyethylene sheeting, at least 6-mil in thickness and located so that packaged materials, after being wiped clean, can be passed to the Holding Room. Separate this room from the Work/Isolation Area by 3-flapped door of 6-mil polyethylene sheeting. Provide a drop cloth layer of plastic on floor in the Washroom for every load-out operation. Roll this drop cloth layer of plastic from Washroom into Work/Isolation Area after each load-out. Provide a minimum of two (2) layers of plastic at all times. Use only clear plastic to cover floors.

E. Holding Room: Provide Holding Room as a drop location for bagged asbestos-containing materials passed from the Washroom. Construct Holding Room of nominal 2" x wood framing and opaque polyethylene sheeting, at least 6-mil in thickness and located so that bagged materials cannot be passed from the Washroom through the Holding Room to the Clean Room. Separate this room from the adjacent rooms by 3-sheet flap doors fabricated from 6-mil sheet plastic.

F. Clean Room: Provide Clean Room to isolate the Holding Room from the building exterior. If possible, locate to provide direct access to the Holding Room from the building exterior. Erect Critical and Primary Barriers as described in Section 01526 "Temporary Enclosures" in an existing space. If no space exists construct Clean Room of 2X4 wood framing and opaque polyethylene sheeting, at least 6 mil in thickness. Separate this room from the exterior by a 3- flap door of 6-mil polyethylene sheeting.

G. Load-out Area: The load-out area is the transfer area from the building to a truck or dumpster. It may be the Clean Room of the Equipment Decontamination unit or a separate room or loading dock area. Erect Critical and Primary barriers as described in Section 01526 "Temporary Enclosures" in load-out area. During transfer of material from load-out area erect primary barriers as described in Section 01526 "Temporary Enclosures" as necessary to seal path from load-out area to truck or dumpster. See Section 02084 Disposal of Environmental Waste Material.

H. Decontamination Sequence: Take all equipment or material from the Work/Isolation Area through the Equipment Decontamination Unit. At the wash down station, thoroughly wet clean all contaminated equipment or sealed polyethylene bags and pass into the Washroom. When passing equipment or containers into the Washroom, close all doorways of the Equipment Decontamination Unit, other than the doorway between the Wash down Station and the Washroom. Keep all outside personnel clear of the Equipment Decontamination Unit. Once inside the washroom, wet clean the bags and/or equipment. When cleaning is complete, pass items into Holding Room. Close all doorways except the doorway between the Holding room and the Clean Room. Workers from the building exterior enter Holding Area and remove decontaminated equipment and/or containers for disposal. Require these workers to wear full protective clothing and appropriate respiratory

protection. At no time is a worker from an uncontaminated area to enter the enclosure when a removal worker is inside.

6.0 CLEANING OF DECONTAMINATION UNITS:

A. Clean debris and residue from inside of Decontamination Units on a daily basis or as otherwise indicated or needed. Damp wipe or hose down all surfaces after each shift change. Clean debris from shower pans on a daily basis or as needed. If the Changing Room of the Personnel Decontamination Unit becomes contaminated with asbestos-containing debris, abandon the entire Decontamination Unit, and erect a new Decontamination Unit. Use the former Changing Room as an inner section of the new Equipment Room.

7.0 SIGNS:

A. Post an approximately 20 inches by 14 inches manufactured caution sign at each entrance to the Work/Isolation Area displaying the following legend with letter sizes and styles of a visibility required by 29 CFR 1926.1101:

LEGEND:

DANGER

ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
WEAR RESPIRATORY PROTECTION
AND
PROTECTIVE CLOTHING ARE REQUIRED
IN THIS AREA

Provide spacing between respective lines at least equal to the height of the respective upper line.

8.0 Lead Paint Stabilization

A. The regulated area utilized during the removal of the asbestos caulk and lead paint on the window frames shall include a decontamination area with soap and water. Each employee entering and exiting the regulated area shall don PPE including disposable overalls, gloves, and safety glasses. Upon exiting the regulated area, each employee shall remove their PPE utilizing a HEPA vacuum to clean their disposable coveralls prior to doffing the PPE in the designated decontamination area. Once the employee removes their disposable suit, the employee shall remove their gloves and proceed to the hand washing station and thoroughly wash hands with soap and water. The water shall be captured and collected for waste characterization. The employee shall not reenter the regulated area without donning the properly PPE.

At the end of each shift, the decontamination area shall be cleaned, and all waste (solid and liquid) shall be collected, bagged/containerized and placed in a locked room. Until the TCLP results indicate the lead levels are less than 5 parts per million (ppm) or 5 milligram per liter (mg/l), the waste must be properly labeled and stored.

END OF SECTION

SECTION 02 82 33.1 – GENERAL AND SPECIALIZED REMOVAL OF ACM

1.0 WORKER PROTECTION:

A. Before beginning work of this section provide workers with the required protective equipment as outlined in Sections 02 82 13.1 and 0282 13.2 or by the OSHA Regulations that is outlined for the type of work being completed. Require that appropriate protective equipment be used at all times.

2.0 LIST OF ASBESTOS CONTAINING MATERIALS:

HA	Material Description	[a]Location	[b]Quantity (Approx.)	[c]Type	[d]Cond / PD	Percent & Type Asbestos
T	Corrugated Paper Type Thermal System Insulation; 8" Diameter	Running North to South in Crawlspace	310 LF	TSI	Poor/ High	65% Chrysotile
U	Hard elbow associated with HA T	Crawlspace	60 Fittings	TSI	Poor/ High	70% Chrysotile
Y	Window Caulk	Exterior side of windows	195 Windows	Misc.	Poor/ High	2% Chrysotile
Z	Window Glazing	Exterior east side of building 1st floor window	**1 each	Misc.	Poor/ High	2% Chrysotile
N/A	TSI Contaminated Soil and Miscellaneous Debris (Depths of Contamination Vary)	Crawlspace	2,000 SF	Misc.	Poor/ High	Assumed
T and U	Hidden Pipe and Fitting Insulation	Potentially concealed in wall cavities	1,000 LF Allowance	TSI	Fair/ High	65-70% Chrysotile
	Asbestos Wiring	Attic, connected to Dry Cell "D" Batteries	<10 LF	TSI	Fair/ High	Presumed
	Mirror Mastic	Behind mirrors in Bathrooms	15 Mirrors	Misc.	Good/ High	Presumed

HA = Homogeneous Area SF = Square feet LF = Linear feet CF = Cubic Feet
[1]Refer to Appendix 2 for specific sample locations.
[2]Quantities are approximate and should not be used for cost estimates or bidding purposes.
[3]Type: Misc. = Miscellaneous Sur = Surfacing TSI = Thermal System Insulation
[4]Cond = Condition: Good, Fair or Poor PD = Accessible during renovation or demolition, Potential for Disturbance; Low/High
**More windows with the asbestos glazing may be present

Note: Quantities are estimates and should not be used for cost estimates or bidding purposes.

Asbestos containing window caulking, window glazing, and mirror mastic shall be removed using nonfriable removal techniques. Non-friable removal techniques will include hand scraping and electric heat guns when needed to loosen the caulking and/or mastic. Open flame equipment such as heat (propane) torches will not be permitted.

Friable materials such as pipe insulation, potentially contaminated debris, and contaminated soil in the crawlspace shall be removed using OSHA Class I removal procedures including Type C respiratory protection or the equivalent. Pipe and fitting insulation above ceilings and in wall cavities shall be removed utilizing friable removal techniques such as the glovebag method. Exploratory testing of the chases located on the exterior walls indicated the piping is uninsulated. However, S&ME suspects there may be additional insulated piping between the floors that was not visible during the assessment. In addition, the steam piping in the crawlspace leaves the building at the southwest end of the building. During the sitework, it is possible to encounter insulated piping during the excavation.

Description of Materials Scheduled to be Abated:

1. Materials to be removed as ACM or ACM contaminated in spaces include but are not limited to those indicated below.
    - Corrugated Paper TSI,
    - Hard elbow associated with corrugated paper TSI,
    - Exterior window caulk,
    - TSI contaminated soil,
    - Potentially contaminated debris in the crawlspace.
    - Hidden pipe and fitting insulation potentially sealed in wall cavities,
    - Asbestos Wiring, and
    - Mirror Mastic.

3.0 GENERAL ASBESTOS REMOVAL PROCEDURES-INTERIOR

A. Removal of asbestos containing and contaminated materials. Follow preparation of work Isolation areas as outlined in other Section 02 82 16.2 – Temporary Enclosures of this specification.

B. Lightly mist ACM to satisfaction of Owner's Representative and/or the Owner's IH asbestos-containing or contaminated materials to be removed. Accomplish misting by a fine spray (mist) of amended water to which a surfactant has been added. Use a mixture of surfactant and water which results in wetting of the Asbestos-Containing/Contaminated Material and retardation of fiber release during disturbance of the material equal to or greater than that provided using one ounce of a surfactant consisting of 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with five gallons of water. Saturate material through to the substrate sufficiently to wet to the substrate without causing excess dripping. Allow time for amended water to penetrate material thoroughly. Spray material repeatedly during the work process to maintain a continuously wet condition. If a removal encapsulant is used, apply in strict accordance with manufacturer's written instructions.

C. The removal of non-friable window caulking and mirror mastic containing asbestos will be performed utilizing wet methods and HEPA vacuum. Each regulated area shall include barrier tape, OSHA Danger Signage, and decontamination area equipped with a HEPA vacuum and water for employees to don and doff PPE. Non-friable removal techniques will include hand scraping and electric heat guns when needed to loosen the caulking and/or mastic. Open flame equipment such as torches will not be permitted.

D. The removal of pipe insulation impacted by the renovation within the interior of the building shall include the glovebag method, and is listed in Section 02 82 13.13, Glovebag Asbestos Abatement.

E. Removal of TSI, contaminated soil and miscellaneous debris from the crawlspace shall be performed using Class I OSHA work practices. During the removal of the TSI, contaminated soil and miscellaneous debris, utilize Type C Air Supplied Respirators or a minimum of Tight-Fitting Powered Air Purifying Respirators. Removal of the pipe insulation and contaminated miscellaneous debris shall include wet methods and prompt cleanup. The cleanup of the soil shall include the removal of the insulation, the contaminated soil and miscellaneous debris. The depth of contamination will vary depending upon previous activities within the crawlspace. It is reasonable to assume the insulation could be compacted within the soil and contamination may extend from a depth of two to three inches. Due to previous visible contamination of ACM being present below the surface of the sub-grade through previous construction activities or water seepage, a sufficient amount of soil shall be removed in the locations until the contamination has been removed from the soil to the satisfaction of the onsite IH and/or Project Designer.

   A full negative pressure enclosure shall be established during the removal of friable ACMs, contaminated debris and soil. The negative pressure enclosure shall consist of critical barriers and a three-stage decontamination unit attached to each enclosure. Depending upon the size of the containments will dictate the number of negative air machines required to maintain -0.02". The critical barriers will include two layers of a minimum of six mil polyethylene sheeting.

   Continuously mist TSI contaminated soil with a surfactant and remove the soil using manual methods. Accomplish misting by a fine spray (mist) of amended water to which a surfactant has been added. Use a mixture of surfactant and water which results in wetting of the Asbestos-Containing Material and retardation of fiber release during disturbance of the material equal to or greater than that provided using one ounce of a surfactant consisting of 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with five gallons of water. Apply amended water to material sufficiently to wet to the soil without causing excess pooling. Allow time for amended water to penetrate soil thoroughly. Spray material repeatedly during the work process to maintain a continuously wet condition. The contaminated soil material shall be removed by digging into the material and removing it in small sections. Remove approximately 2" of soil, from designated area of crawlspace, or until TSI debris is no longer observed. The material shall be placed into labeled 6-mil disposal bags. Evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing. Use the "gooseneck" procedure to seal bags by twisting the neck of the bags, sealing with duct tape, bending the neck of the bag over, and sealing again with a minimum three wraps of duct tape. Clean outside of bag and move to Wash down Station adjacent to Equipment Decontamination Unit.

   An asbestos approved vacuum loader may also be used to remove/collect contaminated soil. S&ME will conduct a visual inspection of the crawlspace once abatement is complete. After the visual inspection is complete, soil sampling within the crawlspace and TEM area samples will be collected to document the cleanliness of the crawlspace.

F. Dry cell "D" batteries were identified in the attic with asbestos insulated wiring. Remove the wiring and discard as ACM waste. Discard the batteries as universal waste per UNC-EHS requirements.

G. Visible mold was identified on the metal support beams in the attic. Cleaning the metal beams with an antimicrobial agent will be required. Once the beams are cleaned, the onsite IH will perform a visual inspection and collect random swabs to verify the cleanliness of the beams. Refer to Section 028713 for more detailed requirements.

4.0 EXTERIOR WORK

A. The windows associated throughout the building were sealed with asbestos caulking. Note: One window was identified to contain asbestos glazing. More windows with asbestos glazing may be present. Carefully evaluate the windows being removed to determine if the glazing is like the window glazing identified on the 1st floor east side of the building. The windows are scheduled to be refurbished and reinstalled. The General Contractor will oversee the removal of the sashes associated with the windows. The window frames will remain intact. The lead paint on the window sashes shall be removed onsite. Refer to Section 028313 for details related to the paint stabilization of the paint on the sashes. A drop cloth comprised of 6 mil polyethylene sheeting shall be placed beneath the windows secured to the exterior wall up 18 inches and extend out 6 feet from the wall. The work area shall include barrier tape, OSHA Danger Signage, and decontamination area equipped with a HEPA vacuum and amended water for employees to don and doff PPE. Manual methods such as hand scraping shall be performed to remove the caulking around the window frame. Once the windows are removed, the residual caulking shall be removed from the window frames including any residual caulking on the interior casing. This work shall be performed on the poly drop cloth beneath the windows. Utilize wet methods and HEPA vacuum during the cleaning process. The window sashes are scheduled to be removed and refurbished by a Subcontractor under the direction of the General Contractor (GC). The GC will be responsible for directing storage of the window sashes once the removal of the lead paint is completed. Refer to Section 028313, Lead Hazard Control Activities, for details related to the paint stabilization of the paint on the windows.

B. ALTERNATE I: WINDOW REPLACEMENT
If the windows are scheduled to be replaced, the abatement of the window caulking will be performed in accordance with Paragraph 4.0A. Because the paint on the windows will not be removed, the windows can be discarded as construction debris.

5.0 FINAL CLEAN UP

A Clean Floor after completion of removal of all environmental contaminated waste materials by wet mopping with amended water. Mop at least three times or until all residue is no longer present, allowing a drying time between each mopping.

B Dispose of all rags, plastic sheet, etc. in accordance with requirements of Section 02 82 33.3, "Disposal of Environmental Containing Waste Material".

C Decontaminate Equipment: After the completion of all work, decontaminate all equipment and machinery used for work of this section. Accomplish decontamination as required by the section on Project Decontamination.

D Compatibility: At the completion of all work, leave substrates in such a state as to comply with all requirements and recommendations of manufacturer for replacement materials.

END OF SECTION

SECTION 02 82 33.2-END OF PROJECT DECONTAMINATION AND VISUALS FOR ACM

1.0 GENERAL

2.0 DESCRIPTION OF REQUIREMENTS:

A. This is a two-step procedure. There are two cleanings of the of the surfaces to remove any new or existing contamination. Unless specifically indicated, all materials are considered damaged and friable for purposes of this section. Operation of the pressure differential system during the performance of the work of this section is used to remove airborne fibers generated by the remediation work.

3.0 RELATED WORK SPECIFIED ELSEWHERE:

A. Removal of Gross Debris is integral with the performance of remediation work and as such is specified in Section 02 82 33.1 Removal of Asbestos Containing Materials.

B. Work/Isolation Area Clearance: Air testing and other requirements that must be met before release of Contractor and re-occupancy of the work area are specified in Section 02 82 13.3 Monitoring and Sampling Requirements.

C. Visual Inspection shall be performed in accordance with ASTM E 1368-90 "Standard Practice for Visual Inspection of Asbestos Remediation Projects" as specified in Section 01092 Codes, Regulations, and Standards and per the Agency for Toxic Substances & Disease Registry (ATSDR) Indoor Air Quality for the mercury levels.

4.0 PROJECT DECONTAMINATION FOR ASBESTOS

A. Work of This Section:
Work of this section includes the decontamination of air in the Work/Isolation Area which has been, or may have been, contaminated by the elevated airborne asbestos fiber levels generated during remediation activities and/or during the removal of the asbestos. The work also covers lowering any previously elevated fiber levels due to friable asbestos-containing materials in the space; the cleaning, decontamination, and removal of temporary facilities installed prior to remediation work, including Critical Barriers, Decontamination Units, and Negative Pressure Differential System components. It also includes the cleaning, and decontamination of all surfaces (ceilings, walls, floors, dirt) of the Work/Isolation Area, and all furniture or equipment in the Work/Isolation Area. After a successful visual inspection has been conducted by the Industrial Hygienist, encapsulation can be applied.

B. Start of Work:
During completion of the asbestos remediation work specified in other sections, all gross debris generated by the asbestos remediation work will be disposed of in a certified landfill. Work of this section begins with the cleaning of the work/isolated area. At the start of work, the following items will be in place:
1. Critical Barrier (an airtight barrier between the Work/Isolation Area and other portions of the building or the outside);
2. Critical Barrier Sheeting (over any item that will not be removed until demolition, and other openings);
3. Decontamination Units for personnel and equipment in operating condition;
4. Negative Pressure Differential System in operation.

C. Cleaning of Regulated Work Area
1. First Cleaning: Carry out a first cleaning of all surfaces of the work area including items of remaining sheeting, tools, scaffolding and/or staging by use of damp-cleaning and mopping, and/or a High Efficiency Particulate Air (HEPA) filtered vacuum. (Note: A HEPA vacuum may fail if used with wet material.) Do not perform dry dusting or dry sweeping. Use each surface of a cleaning cloth one time only and then dispose of as contaminated waste. Continue this

cleaning until there is no visible debris from removed materials or residue on plastic sheeting or other surfaces.

a. Replace All Filters in Air Filtration Devices(s) and dispose of as asbestos-containing waste in accordance with requirements of Section 02 82 33.3 Disposal of Asbestos-Containing Waste Material and Construction Waste.

2. Final Cleaning:
Carry out a final cleaning of all surfaces in the Work/Isolation Area in the same manner as the previous cleaning.

D. Contractor's Visual Inspection and Cleaning: At the completion of the above cleaning contractor's supervisor is to visually inspect all surfaces. Reclean if any dust, debris, etc. is found. At completion of this inspection sweep entire Work/Isolation Area including walls, ceilings, ledges, floors, and other surfaces in the Work/Isolation Area with exhaust from forced air equipment (leaf blower with approximately 1 horsepower electric motor or equivalent). Do not direct forced air equipment at any seal in any critical barrier. If any debris or dust is found, repeat the final cleaning. Continue this process until no debris, dust or other material is found while sweeping of all surfaces with forced air equipment.

1. Following Final Cleaning the Project Superintendent and/or Supervisor shall complete a final visual inspection of the entire Work/Isolation Area including: all surfaces, ceiling, walls, floor, decontamination unit, all plastic sheeting, seals over ventilation openings, doorways, windows, and other openings; look for debris from any sources, residue on surfaces, dust or other matter. Ensure that no standing moisture or condensation is visible prior to performing the inspection.

2. Ensure that all waste has been removed from the work area. During visual inspection entire work area will be swept, including walls, ceilings, ledges, floors, soil crawlspace and other surfaces in the room with exhaust from forced air equipment (leaf blower with approximately 1 horsepower electric motor or equivalent). If any debris, residue, dust, or other matter is found, repeat final cleaning, and continue decontamination procedure from that point.

3. Temporary lighting: Provide a minimum of 100 watt of lighting on all surfaces in the areas to be subjected to visual inspection. Provide handheld lights providing 100 watt of lighting at 4 feet capable of reaching all locations in work area. If adequate lighting is not provided during the work process, for the IH during visual inspections, and/or during air monitoring, the project will be shut down until lighting is provided. There will be no additional time allotted to the contractor for the project for these circumstances.

4. Lifts: Provide ladders, scaffolding, and lifts as required to provide access to all surfaces in the area to be subjected to visual inspection by the IH. The definition of "access" is to allow touching of all surfaces.

5. When the area is visually clean, if no debris, residue, dust or other material is found, the Contractor's Supervisor/Project Manager will request the Building Owner's Representative, Industrial Hygienist, and/or Project Manager to complete the Final Clearance Visual Inspection. Area is not ready for Clearance Air Monitoring until Visual inspection is complete and confirmed in writing by IH and/or the Project Manager on the Certificate of Visual Inspection.

5.0 INDUSTRIAL HYGIENIST/PROJECT MANAGER FINAL VISUAL CLEARANCE

A. IH Visual Inspection: The visual inspection will be completed and passed by the building owner's IH/Project Manager prior to the final air clearance for the asbestos remediation. The visual inspection will be completed upon request of the Contractor's Supervisor/Project Manager, not before. Removal of non-friable materials will only require a visual inspection.

6.0 FINAL AIR SAMPLING:

A. After the work area is found to be visually clean, air samples and soil samples will be taken and analyzed from the abatement of the ACM in the crawlspace in accordance with the procedures set forth in Section 02 82 13.3 Monitoring and Sampling Requirements. If Release Criteria are not met, repeat Final Cleaning, and continue Decontamination Procedure from that point. If Release Criteria are met, proceed to removal of Work Area Isolation.

B. Removal of Work/Isolation Area:
After all requirements of this section and Section 02 82 13.3 Monitoring and Sampling Requirements have been met, shut down and remove the Pressure Differential System. Seal HEPA filtered fan units, HEPA vacuums, and similar equipment with 6-mil polyethylene sheet and duct tape to form a tight seal at intake end before being moved from Work/Isolation Area. Remove Personnel Decontamination Unit. Remove the Critical Barriers separating the Work/Isolation Area from the rest of the building. Remove any small quantities of residual material found upon removal of the plastic sheeting with wet wiping, HEPA filtered vacuum cleaners and poly sheeting. If significant quantities, as determined by the Owner's Representative, are found then the entire area affected shall be decontaminated as specified. Cleaning & Decontamination Procedures. Remove all equipment, materials, and debris from the work site. Dispose of all asbestos-containing waste material as specified in Section 02 82 33.3 Disposal of Asbestos-Containing Waste Material and Construction Waste.

7.0 OTHER CONTAMINANTS

A. Visual: A final visual inspections will be completed to ensure that light tubes, ballasts, and other environmental hazardous contaminants have been removed including the visible mold on the structural steel frame in the attic and the removal of the “D” cell batteries.

END OF SECTION

SECTION 02 82 33.3 - DISPOSAL OF ASBESTOS CONTAINING MATERIAL AND CONSTRUCTION WASTE MATERIAL

1.0 GENERAL

2.0 DESCRIPTION OF THE WORK:

A. This section describes the disposal of Environmental and Construction waste materials. The Environmental Waste Disposal includes packaging of asbestos containing, and other environmental contaminated waste materials. Comply with Section 02 82 13.1-Worker Protection–and Section 02 82 13.2 Respiratory Protection/Personnel Monitoring during all phases of this work.

B. The Contractor is responsible for all waste, including construction and environmental (hazard and nonhazardous) waste.

C. All environmental and construction waste material must be carefully lowered to the ground or floor, by not dropping, throwing, or otherwise damaging or disturbing the material.

D. The Contractor shall ensure that each employee has access to labels on containers of asbestos and other hazardous waste (i.e. Lead-based paint, etc.) and the safety data sheets, and each employee is trained in accordance with the provisions of HCS and paragraphs (k)(9) and (10) of this section. The employer shall provide information on at least the following hazards: Cancer and lung effects and other health effects.

3.0 WASTE MINIMIZATION PLAN (WMP)

A. The Environmental/Demolition Contractor will provide a Waste Minimization Plan (WMP). This WMP should outline the methodologies used to ensure that maximum quantities of waste generated are recycled, recovered, or reused, as well as measures for minimizing waste generated from construction/demolition debris. A copy of the plan will be submitted by the contractor awarded the project. Copies of waste tickets for recycled, recovered or reused materials will be submitted to the Project Designer. These tickets are not required to show remuneration that the Contractor received for the materials.

4.0 STORAGE OF ASBESTOS WASTE

A. Asbestos or hazardous waste is not to be stored at any location, other than the facility site, without prior written approval from the Project Designer or Building Owner.

B. Stored asbestos or hazardous waste must be maintained in a secured locked location where access is controlled.

5.0 ASBESTOS DISPOSAL CONTAINERS

A. Asbestos Disposal Bags place adequately wet asbestos containing waste material into 6 mil thick leak-tight polyethylene bags; evacuate air from disposal bags with a HEPA filtered vacuum cleaner before sealing. Place first bagged waste into a second disposal bag; use the "gooseneck" procedure to seal bags. These procedures is accomplished by twisting the neck of the bags, wrapping the twist with duct tape then bending the neck of the bag over, and seal the twists again with duct tape. Clean outside of bags and move the bags to the Wash down Station adjacent to Equipment Decontamination Unit.

B. Disposal bag and drum place adequately wet asbestos containing waste material into 6 mil thick leak-tight polyethylene bags; evacuate air from disposal bag with a HEPA filtered vacuum cleaner before sealing. Use the "gooseneck" procedure to seal bag, this is accomplished by twisting the neck of the bags, wrapping the twist with duct tape then bending the neck of the bag over, and sealing the twists again with duct tape. Clean outside of the bag at the Wash down Station adjacent to Equipment Decontamination Unit and place in a fiber or steel drum.

C. Two layers of 6 mil poly sheeting, independently wrapped and sealed shall be utilized for the windows scheduled to be discarded and sections of piping scheduled to wrapped, cut, and discarded as ACM.

D. LABELING OF DISPOSAL CONTAINERS FOR ASBESTOS:

1. Waste generator labels are:
   a. Written legibly and in indelible ink.

   b. Displayed in a prominent location on the outer most area of the bag or container chosen disposal container the following three labels must be placed and visible:

2. First Label: Provide in accordance with 29 CFR 1926.1101(k)(8)(iii) Labels in OSHA's Asbestos in Construction (Regulation Changed June 1, 2015).

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

3. Second Label: Until October 1, 1993, provide in accordance with U. S. Department of Transportation regulation on hazardous waste marking, 49 CFR parts 171 and 172. Hazardous Substances: As outlined in Rule. Published November 21, 1986 and revised February 17, 1987. New revisions are in effect as of June 1, 2015. Contractor needs to placard in the most current regulations.

RQ HAZARDOUS
SUBSTANCE,
SOLID, NOS,
ORM-E, NA 9188
(ASBESTOS)

4. Third Label: Provide in accordance with 40 CFR Part 61 (AMENDED), subpart M, section 61.150(a)(1)(v) of EPA's National Emission Standards for Hazardous Air Pollutants; Asbestos NESHAP Provision, published November 20, 1990.

CONTRACTOR:
WASTE GENERATOR NAME:
ADDRESS OF WORKSITE:
CITY: STATE: ZIP:

5. All waste is to be hauled by a waste hauler with all required licenses from all state and local authorities with jurisdiction.

6. As per NESHAP 61.150 vii (3)(4) waste shipment records shall be obtained from the landfill/or hauler within 35 days, if not received within 45 days, EPA shall be notified by the contractor of unresponsive records.

7. Asbestos waste is disposed of at a landfill approved or permitted to accept asbestos waste.

4.0 ASBESTOS WASTE TRANSPORTATION

A. Asbestos waste is transported and disposed of in a manner that will not permit the release of asbestos fibers into the air. Also, the asbestos waste is transported in accordance with the following procedures:

1. The cargo area of the transport vehicle shall be free of debris and lined with 6-mil polyethylene sheeting. Floor sheeting shall be installed first and shall extend up the side walls at least 12 inches and shall be taped securely into place. Wall sheeting shall overlap by at least six inches and be taped into place.
2. If asbestos waste is transported exclusively in leak-tight clean drums, or other leak-tight, rigid containers approved by the US Department of Transportation as appropriate shipping containers for asbestos waste, then polyethylene sheeting is not required.
3. Drums, bags, wrapped components, and other leak-tight containers that have been removed from the work area shall be labeled in accordance with H.1.a. of this section prior to being loaded into an appropriate vehicle for transportation.
4. Any debris or residue observed on containers or surfaces outside of the work area resulting from abatement activities shall immediately be cleaned using wet methods and a vacuum equipped with a HEPA filter.
5. Containers shall be carefully placed and not thrown into the truck cargo area. Drums shall be placed on a level surface in the cargo area and packed tightly or blocked and braced to prevent shifting and tipping. Large structural components shall be secured to prevent shifting.
6. Asbestos waste which is removed from a facility site shall be transported directly to an approved landfill unless it is stored in the location designated in a temporary storage license issued to the owner/operator by the Department.
7. Metal dumpsters or containers in which asbestos waste is temporarily stored at the abatement site shall be lined with 6-mil polyethylene sheeting to prevent contamination and shall have doors and tops. The doors and tops shall be closed and locked except during loading or unloading asbestos waste.
8. Metal dumpsters or containers used for waste storage shall be labeled in accordance with OSHA 29 CFR 1926.1101, August 10, 1994 as amended, and any subsequent amendments and editions.
9. Bags shall be free of splits, rips and tears, and shall be carefully placed, not thrown, into the transport vehicle.
10. Any equipment, materials, or supplies stored in the waste transport vehicle shall be isolated from the asbestos waste by a leak-tight barrier. All containers and wrappings shall be free of asbestos contamination.
11. Non-asbestos waste shall not be placed in waste containers or bags labeled as asbestos waste.
12. The vehicle used to transport asbestos wastes shall be labeled in accordance with 40 CFR 61.149(d)(1)(I, ii, and iii) as amended, and any subsequent amendments and editions.
13. Commercial rental vehicles shall not be used to transport any asbestos, asbestos-containing, or asbestos-contaminated waste. This prohibition does not apply to tractors but does apply to cargo compartment areas which are used to store and/or transport asbestos waste. Rental vehicles do not include leased vehicles.

5.0 DISPOSAL OF ASBESTOS OR CONSTRUCTION WASTE AT LANDFILL

A. The owner/operator shall dispose of asbestos waste in accordance with the following procedures:

1. Upon reaching the landfill, vehicles shall approach the dump location as closely as possible to unload asbestos waste.
2. Bags, drums and wrapped components shall be inspected when unloaded at the disposal site. Material in damaged containers shall be rewrapped or shall be repacked in empty drums or bags.
3. Waste containers shall be placed on the ground at the disposal site, not dropped or thrown out.
4. Unloading of metal dumpsters or containers by tipping or tilting is permitted without reinspecting individual bags or drums provided there are no visible emissions.

5. Following the removal of all containerized waste, polyethylene sheeting shall be removed and discarded in bags or drums along with contaminated cleaning materials and protective clothing.
6. After asbestos waste has been unloaded, the truck cargo area, including the floor, walls and ceiling, shall be decontaminated using wet methods or a vacuum equipped with a HEPA filter until no visible residues remain.
7. A copy of a completed waste shipment record shall be submitted to the Department by the asbestos contractor within 45 days of completion of abatement.
8. A waste shipment record shall be used and shall include the names of the facility owner, contractor and disposal site, the estimated quantity of asbestos waste, and the type and number of containers used. Each time the material changes custody, the record shall be signed by the persons receiving the waste. If a separate hauler is used, the hauler's name, address, telephone number and the driver's signature shall also appear on the record.
9. The owner/operator shall ensure that asbestos-containing or asbestos-contaminated waste materials are not burned or recycled.

6.0 RECYCLING OF NON-HAZARDOUS DEMOLITION DEBRIS

The contractor should segregate and recycle demolition debris to the extent possible. The contractor is responsible for coordinating recycling and waste disposal. The contractor should discuss and understand the segregation requirements, the maximum acceptable material size and types/sizes of transport containers with the solid waste disposal contractors. Materials to be recycled include, but are not limited to metal pipes, ductwork, fume hoods and sinks. The contractor is responsible for coordinating construction and demolition debris disposal.

The contractor is required to submit a Draft Solid Waste Management Plan fourteen days prior to beginning work activities. The draft should be submitted simultaneously to the designer and the UNC Office of Waste Reduction and Recycling (OWRR) in order to expedite plan review. Once OWRR has communicated requested changes, the contractor has five business days to submit a Final Solid Waste Management Plan (SWMP) (UNC Specification 01505). Any deviance from the final SWMP must be approved by OWRR. In accordance with Specification 01505, each month the contractor must submit documentation (weight tickets, manifests, etc.) of the disposal, recycling, re-use, and salvage of all materials and a summary with each Payment Application. Failure to do so may delay payment. See UNC Design and Construction Guidelines for additional information concerning recycling of non-hazardous materials.

7.0 CONTRACTOR CERTIFICATION OF CLEAN AND QUALITY CONTROL

The contractor shall complete the required work and certify that each area is clean and free of hazardous materials based on applicable federal, state and local regulations. Work areas and other areas should be clean and free of debris, dirt and dust following remediation activities. The contractor will not be responsible for collecting final clearance samples. A UNC representative will collect samples in certain locations to document the condition of the areas sampled. The contractor's environmental health and safety manager shall keep a written log of areas where work was completed, the type of work, the dates work were completed in the area, the quantity of materials removed from the area and any laboratory testing completed. This information should be updated daily, kept in a binder onsite and provided to UNC-EHS and/or the designer upon request. For additional information refer to the AIA Specifications included in Section III – AIA Specifications - Section 01450 – Quality Control. Quality control documentation forms are included in this section.

At the conclusion of each phase of environmental demolition, the following individuals will walk the site together to review the completed work and check for deficiencies:

Architect
Environmental Abatement designer
Environmental demolition contractor

Construction manager
EHS representative
General contractor/CM responsible for subsequent renovation work

The architect and the environmental abatement designer will attest in writing that all hazardous material has been abated or secured according to the specifications and no remaining hazardous material will be disturbed in this space by subsequent construction activity in this space.

If all hazmat has not been addressed, the architect will prepare a punch list of deficiencies to be corrected at the contractor's expense. While fixing the punch list items, the contractor is expected to use the required protective measures necessary to complete the work as outlined by the abatement designer.

If the construction manager or the EHS representative disagrees with the clearance assessment of the architect and consultant, additional testing may be required. If this testing reveals residual contamination, the cost of this testing and additional testing shall be born by the architect and the consultant. Additional abatement expense shall be absorbed by the environmental demolition contractor.

The next phase of construction can begin in the designated workspace after all parties agree on the clearance and the architect and consultant sign a document to release the space.

8.0 WASTE MANIFESTS

A. Copies of all waste manifests and/or signed receipts from all landfills that received hazardous waste and/or construction wastes from this project will be submitted.

B. All work will be performed in accordance with all applicable federal, state, and local regulations.

C. Cost of Disposal of all materials is part of this contract.

END OF SECTION

SECTION 02 83 13 – LEAD HAZARD CONTROL ACTIVITIES

1.0 OSHA LEAD IN CONSTRUCTION REQUIREMENTS 29 CFR 1926.62

A. The OSHA regulation does not stipulate a minimum lead content so the presence of any amount of lead, even lead at levels below the detection limit, may cause exposures to lead that will require compliance with the lead regulations.

B. OSHA considers paint a *potential* hazard if it contains any amount of lead by dry weight when analyzed using ASTM D335-85A “Standard Method to Test for Low Concentrations of Lead in Paint by Atomic Absorption Spectroscopy (AAS)”. This standard applies to areas that may be disturbed during renovation or demolition activities.

C. Workers scheduled to perform the demolition activities will disturb the lead-containing paint and will need to be trained on the hazards of lead per the requirements outlined in 29 CFR 1926.62. This training includes a detailed description of the hazards to the developing fetus in pregnant women exposed to lead and the importance of personal hygiene, including decontamination procedures for controlling the spread of the lead hazard. The workers are also required to be trained according to 29 CFR 1910.1200 (Hazard Communication). All personnel working with lead are to be medically qualified as required by 29 CFR 1926.62, having completed, and passed the physical examination specified therein.

D. OSHA also requires employers to perform an initial exposure assessment of their workers to assess their exposure to lead-containing dust. Workers are to be protected during the exposure assessment period and, if high levels of lead are found in the air, they must continue to wear personal protective equipment and use engineering controls to reduce the airborne lead levels. The employer must demonstrate that worker exposure is below the 30 $\mu g/m^3$ eight-hour time weighted average action level to eliminate further exposure assessment of a specific task.

Identified Lead Containing Paint

Sample Number	Substrate	Component	Color	Sample Location	Concentration (% by weight)
Pb-01	Metal	Radiator	Crème	Rooms	0.60
Pb-02	Metal	Interior Window Casing	Cream	Rooms	0.66
Pb-03	Metal	Exterior Window Frame	Tan	Exterior	13.0

E. North Carolina solid waste disposal regulations do not stipulate disposal requirements for components coated with lead-containing paint or lead-based paint, meaning the construction debris can be discarded in a construction and demolition landfill. If the paint is removed from the substrate/component, samples must be collected and tested using the Toxicity Characteristic Leaching Procedure (TCLP) to determine the waste stream.

F. The tan paint on the exterior and the white paint on the interior windows shall be removed in accordance with OSHA 29 CFR 1926.62. The contractor shall designate an area to perform the paint stabilization of the window frames. Demarcate the area with barrier tape and signage which indicates lead hazards. Utilizing manual methods, remove the residual paint from the frames. Once the paint is removed, utilize disposable wipes to clean the frame, only utilizing the wipe to conduct one pass over the frame and discard as lead-contaminated debris. Any liquid waste generated during the removal of the paint, including the paint chips shall be discarded as hazardous waste. A TCLP sample shall be collected by the Contractor, and the results must be reported to Mr. Mike Long with EHS, 919-962-5509, mdlong@unc.edu prior to disposal. The employees performing the paint stabilization shall don and doff PPE

G. Lead-containing paint and lead-based paint were identified. The contractor shall assume lead-containing paint is present due to the 1927 date of construction. The contractor is responsible for OSHA compliance with 29 CFR 1926.62-OSHA Lead Construction Standard. This is strictly an OSHA concern for the Contractor and should not impact the price for abatement. In addition, the contractor is responsible for any requirement of TCLP sampling for disposal purposes.

END OF SECTION

SECTION 02 84 16 – HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBS AND MERCURY

1.0 FLUORESCENT LIGHT TUBES

A. This work will be performed in accordance with all applicable federal, state, and local regulations.

1. Contractor shall remove fluorescent lighting fixtures and segregate them from other waste generated during the remediation. Once segregated, the contractor shall remove the fluorescent tubes (intact) from the light fixture and move them to a designated bulb disposal area.

2. Fluorescent light tubes contain low levels of mercury and are a Universal Waste; fluorescent light tubes must be managed as a universal waste in accordance with the regulations including managing the fluorescent tubes (a.k.a. lamps) in a way that prevents the release of any universal waste or component of a universal waste to the environment.

3. The contractor is considered a small quantity handler of universal waste and must contain any lamp in a container that is structurally sound, adequate to prevent breakage and compatible with the lamps and not show evidence of leakage or breakage of the lamps. In addition, the container package must be marked with any of the following phrases: “Universal Waste-Lamps, Waste Lamps or Used Lamps” and each container package must be marked with the date that the first lamp was placed into the container package and the small quantity generator may accumulate lamps in the container package no longer than one year from the date on the container package.

4. This work will be performed in accordance with all applicable federal, state, and local regulations.

2.0 LIGHT BALLAST CONTAINING PCB’S

A Once the fluorescent light tubes have been removed from the light fixtures, the contractor shall remove ballast suspected of containing Polychlorinated Biphenyls (PCBs). The PCB ballasts are to be removed intact, placed in containers provided by the Contractor, and packaged for disposal. Once the containers are full, the contractor will properly dispose or recycled and incur the cost.

B The contractor shall safely remove ballasts and observe the written information on the ballast. Ballasts that contain PCBs shall be placed into a UN approved 55-gallon drum for disposal and shall be shipped on a Hazardous Waste Manifest. The lid on the drum shall be secured unless the contractor is actively placing ballasts into the drum. A Class 9 label should be placed on the drum as soon as the first ballast is placed into it. The contractor will consider a ballast as containing PCBs if the written information of the ballast indicates it contains PCBs or does not clearly indicate it does not contain PCBs.

C Non-PCB ballasts will have “No PCB’s” written on them. The contractor shall place non-PCB ballasts in a different UN-approved 55-gallon drum. Only non-PCB ballasts shall be placed in the drum. The lid on the drum shall be secured unless the contractor is actively placing ballasts into the drum. The drum should be labeled as soon as the first ballast is added.

3.0 DISPOSAL REQUIREMENTS OF FLUORESCENT LIGHT TUBES AND LIGHT BALLAST CONTAINING PCB’S

A. Once the fluorescent light tubes have been removed from the light fixtures, the contractor shall remove ballast suspected of containing Polychlorinated Biphenyls (PCBs). Once the ballasts are removed intact and placed in appropriate containers and packaged for disposal. Once the containers are full, they are to be moved to a designated hazardous waste site until removed from the project site by the contractor.

B. Once fluorescent light tubes and ballast have been removed, the light fixtures can be disposed of as construction waste or sent for recycling.

C. A Universal Waste label shall be placed on each box as soon as one bulb is placed into the box. If a bulb does break it shall be handled as hazardous waste and the materials should be properly contained in a UN polyethylene drum and disposed of properly, and in a timely manner. The container must be capped with a lid that ensures no material will be spilled from the container during storage or transport and labeled appropriately, including a class 8 corrosive sticker.

D. UNC defines hazardous and universal wastes as any waste material that poses a human health threat or may cause damage to the environment. Disposal options should be thoroughly investigated for these materials and may involve recycling, reuse, or disposal. Irresponsible discharges to the environment or improperly managing waste should be avoided. It is imperative that the use, handling, storage, transportation and disposal of hazardous and recyclable materials and waste from UNC facilities and the UNC campus are consistently managed following the guidelines outlined in federal, state, local and UNC regulations and other hazardous waste regulations. Items contaminated with Hazardous material must be decontaminated and sampled to confirm the hazardous materials were removed or shall be disposed of as hazardous waste. All hazardous and universal waste disposal must be cleared through UNC-EHS. The EHS Hazardous Material Manager – 919.962.5509. Containers used to store hazardous waste must be approved by the United States Department of Transportation (DOT). The contractor shall supply necessary containers. The containers shall remain closed except when material is being placed into them. Each container shall be labeled with a properly completed hazardous waste label as soon as any quantity of waste is placed into it. UNC-EHS must observe waste sampling, review all testing data, evaluate waste determinations, and must sign all manifests.
    i. The contractor will comply with all regulations and conditions of UNC permits and licenses applicable to the project. Included are wastewater discharge permits and satellite accumulation requirements for hazardous waste, etc.
    ii. The contractor assumes responsibility and liability for compliance with all applicable regulations especially those affecting the health and safety of contractor employees, subcontractors, and all others at UNC during the performance of the work. This responsibility includes the protection of UNC employees and visitors located near the worksite. Prevention of damage to UNC property, supplies, and equipment from accidents, improper storage or misuse of hazardous materials shall also be avoided.
    iii. Hazardous materials and waste may be accumulated and temporarily stored on UNC property per the provision of UNC's hazardous waste permit, but should not exceed 30 days, except for extremely hazardous materials, for which arrangements should be made to remove the material for the premises as soon as is practicable. The following conditions should be met to ensure that hazardous substances are properly managed:
        1. Hazardous waste containers should be in good condition, compatible with the material being stored in it, properly labeled at all times, and free of leaks.
        2. Adequate secondary containment should be provided for those wastes where accidental discharges or leaks could cause an environmental release.
        3. Hazardous waste accumulation areas will be pre-approved by the owner and designer before wastes are stored there. The areas will be open for inspection by the owner or designer upon request. Hazardous waste accumulation areas shall also be inspected at least daily by the contractor or its environmental oversight subcontractor and shall be locked when not in use. Wastes in containers that are leaking will be immediately transferred to a reliable container and any spilled material properly cleaned up.

4. The contractor should coordinate waste disposals with one or more of the UNC approved vendors listed below (as listed on the UNC website). The contractor is responsible for the disposal fees of hazardous and universal waste disposal.
5. Do not ship any Hazardous or Universal Wastes without EHS notification and approval. EHS must be notified to ensure that the proper paperwork, with the correct EPA ID number, addresses, and emergency contact information is used. An EHS representative MUST sign all paperwork for recycling or disposal shipments Universal or Hazardous Waste, including Bulbs.

END OF SECTION

SECTION 02 88 13– MOLD REMEDIATION

1.0 WORKER PROTECTION:
Before beginning work of this section provide workers with the required protective equipment as outlined in Sections 02 82 13.1 and 0282 13.2 or by the OSHA Regulations that is outlined for the type of work being completed. Require that appropriate protective equipment be used at all times.

2.0 GENERAL MOLD REMEDIATION:
Visible mold was identified on the structural steel beams in the attic. Contractors should comply with the OSHA Illumination Standard 1926.56 to provide an adequate amount of lighting during the mold remediation and final visual clearance. Clean the metal beams with a HEPA Vac to remove all accumulated dust and apply an EPA approved antimicrobial agent. A Safety Data Sheet (SDS) for the antimicrobial agent shall be submitted to the Project Designer for approval prior use. Follow the manufacturer's instructions and safety precautions to reduce the potential for fire hazards and occupant safety issues when administering an antimicrobial agent.

3.0 ANTIMICROBIAL APPLICATION:
Apply only Federal/state government registered or authorized products and follow the label/SDS instructions explicitly. The product SDS sheet must be submitted to the Project Designer and UNC EHS for approval prior to use.

4.0 CLEANING PROCEDURES:

4.1 Pre-cleaning is an essential first step prior to the application of an antimicrobial agent. Use Fiberlock® Shockwave or equivalent on all surfaces within the attic having visible microbial growth. Allow a minimum of two hours for the application to dry or when the surface is dry to the touch.

4.2 Apply Fiberlock® IAQ 6000 to all cleaned surfaces in accordance with manufacturer's instructions.

5.0 POST ATTIC REMEDIATION:
Upon completion of the mold remediation in the attic, S&ME will conduct a visual inspection of the metal frame surfaces. The IH may choose to collect random swabs from the beams to verify the cleanliness of the beams, if cleanliness is questionable. No air samples will be collected. This will be restricted to a visual inspection, unless the IH determines the random collection of swab samples is warranted.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE FOR BUILDINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
   2. Indicate limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
   1. Include special reinforcement required for openings through concrete structures and dimensioned opening locations. Include applicable dimensions, sections, elevations, and details required to complete installation and coordination of the details, and typical details. Plan shall be drawn at a scale of no less than 1/8” per foot.

1.6 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Steel reinforcement and accessories.
   4. Waterstops.
   5. Curing compounds.
   6. Floor and slab treatments.
   7. Vapor retarders.

B. Material Test Reports: For the following, from a qualified testing agency:
   1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 305.1 and as follows:
   1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301.

2. ACI 117.
3. ACI 315.
4. CRSI “Manual of Standard Practice.”
5. ACI 318.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material (cement and fly ash) of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer for all concrete in this Division 033000 “Cast-In-Place Concrete for Buildings” and Division 321313 “Concrete Paving”. Contractor shall be responsible for coordinating this requirement between trades and sub-contractors such that exposed concrete on the project for building slabs and pavement have a consistent appearance.

B. Cementitious Materials:
   1. Portland Cement: ASTM C 150/C 150M, Type I/ II, gray.
   2. Fly Ash: ASTM C 618, Class F.

C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 1-1/2 inches, nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Water: ASTM C 94/C 94M and potable.

2.6 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A, with maximum water-vapor permeance of 0.01 perms per ASTM E 96. Include manufacturer's recommended adhesive or pressure-sensitive tape, 15 mil thickness.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.
1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Slump Limit: 4 inches, plus or minus 1 inch.
3. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Slabs-on-Grade: Normal-weight concrete.
1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches maximum for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

A. Slabs-on-Grade: Normal-weight concrete.
1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.

3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches maximum for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

B. Housekeeping pad on Elevated Structure: Light-weight concrete.
1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches maximum for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

C. Exterior Slabs-on-Grade and Retaining Walls: Normal-weight concrete.
1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum W/C Ratio: 0.45.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches maximum for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

D. All Other Concrete: Normal-weight concrete.
1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch or 8 inches maximum for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

E. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Joints shall be cut the same day slab is placed and no longer than 8 hours after concrete placement.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 WATERSTOP INSTALLATION

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.8 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces to receive trowel finish.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet and apparatus bay floors to receive sealed finish.
   2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
      a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method (first and second floor slab areas). While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

3.10 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases to height indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 3000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces. Concrete shall be normal weight with minimum compressive strength of 3000 psi.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.13 SPECIAL INSPECTIONS

A. Special Inspections will be performed by the Owner’s Special Inspector.

B. Verification and inspection of concrete construction shall be in accordance with the 2018 North Carolina State Building Code and as follows:

C. Inspections:
1. Steel reinforcement placement.
2. Headed bolts and studs.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure five 4 x 8 standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimen at 7 days and one set of three specimens at 28 days. Maintain one specimen in reserve for later testing, if required.

a. A compressive-strength test shall be the average compressive strength from a set of specimens obtained from same composite sample and tested at age indicated.
b. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

7. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
8. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
9. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

G. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

H. Prepare test and inspection reports.

END OF SECTION

SECTION 03 35 50 - CONCRETE FLOOR HARDENING

PART 1 GENERAL

1.01 SUMMARY

A. Hardened and burnished concrete floors.

1.02 REFERENCES

A. ANSI/NFSI B101.3 - Test Method for Measuring the Wet DCOF of Hard Surface Walkways; 2020.

B. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.

C. ASTM C779 - Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces; 2019.

D. ASTM C805 - Standard Test Method for Rebound Number of Hardened Concrete; 2018.

E. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test; 2022.

F. ASTM G152 - Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetalic Materials; 2013.

1.03 SUBMITTALS

A. Product Data.

B. Hardening compound manufacturer's detailed application instructions.
   1. Cleaning prior to application.
   2. Hardening.
   3. Burnishing.

C. Hardening compound manufacturer's floor care instructions: daily/monthly/annually.

D. Installer Qualifications.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Certified by and trained by the manufacturer for application of flooring products specified herein.

B. Notification: Give at least 7 calendar days' notice before date established for commencement of work to:
   1. Hardening compound manufacturer's technical representative.

1.05 PROJECT CONDITIONS

A. Schedule construction activities so that operations that occur before floor finishing do not cause permanent, inadvertent staining or damage to substrates. Provide protection as necessary.

B. Schedule construction activities so that operations that occur after floor finishing do not cause permanent, inadvertent staining or damage to finished floors. Provide protection as necessary.

C. Provide at least 50 foot candles (538.2 Lux) of uniform illumination during floor finishing operations.

1.06 MAINTENANCE PRODUCTS

A. Provide 6 months maintenance supply of cleaning agent for Owner's use.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 PRODUCTS

A. Hardened and Burnished Concrete Floor Finish:
   1. Penetrating, sodium silicate based, chemically hardening compound that reacts with free lime and calcium carbonate in the concrete paste. Lithium based compounds not acceptable. Topical, film-forming compounds not acceptable. Suitable for burnishing to a satin sheen.
      a. Abrasion Resistance to Revolving Disks: At least a 32.5% improvement over untreated samples when tested in accordance with ASTM C779.
      b. Surface Adhesion: At least a 22% increase in adhesion for epoxy when tested in accordance with ASTM D3359.
      c. Hardening: As follows when tested in accordance with ASTM C39/C39M:
         1) After 7 Days: An increase of at least 40% over untreated samples.
         2) After 28 Days: An increase of at least 38% over untreated samples.
      d. Dynamic Coefficient of Friction (DCOF): Minimum 0.42, wet when tested in accordance with ANSI/NFSI B101.3.
      e. Rebound Number: An increase of at least 13.3% over untreated samples when tested in accordance with ASTM C805.
      f. Light Exposure Degradation: No evidence of adverse effects on treated samples when tested in accordance with ASTM G152.
   2. Basis of Design: "The Ashford Formula"; Curecrete Chemical Company.

B. Burnishing pads; distributed by Advanced Floor Products.

C. Crack and Joint Fillers:
   1. "CreteFill Pro" series; CureCrete Chemical Company.
   2. "CreteFill Crack Repair" series; CureCrete Chemical Company.
   3. Color as selected by the Architect.

D. Compounds for Cracks, Spalls, and Other Repairs:
   1. "CreteFill" series; CureCrete Chemical Company.
   2. Color to match adjacent concrete and as approved by the Architect based on mock-up.

E. Chemical Cleaning Agents:
   1. Basis of Design: "Preclean Plus"; Curecrete Chemical Company.

F. Maintenance Supplies:
   1. "CreteClean Plus"; CureCrete Chemical Company.

PART 3 EXECUTION

3.01 PRE-APPLICATION REQUIREMENTS

A. Petroleum and hydraulic fluid stains typically cannot be removed. Do not allow the use of equipment that might permanently stain.

B. Where use of equipment containing hydraulics is essential, diaper the equipment.

C. Do not park vehicles in areas to be finished.

D. Provide non-marking (white) tires on equipment.

E. Do not scratch or chip floors.

F. Do not allow pipe cutting machinery (manual or powered) in areas to be finished.

G. Do not place steel on floors to avoid rust staining.

H. Clean up spills immediately and spot-treat stains with degreaser or oil emulsifier.

3.02 PREPARATION

A. Remove contaminants and existing coatings from concrete surfaces to receive floor finish. Perform operations in accordance with hardening compound manufacturer's detailed written instructions.

B. Ensure that concrete surfaces are completely penetrable before applying the initial application of chemical stain or hardening compound. Chemically clean or mechanically abrade the surface of the concrete to remove weak cement paste and contaminants and coatings. The final surface preparation shall approximate a Concrete Surface Profile of 1, (CSP1 as designated by the International Concrete Repair Institute, Alexandria, Virginia) unless otherwise recommended by hardening compound manufacturer and approved by the Architect. Contractor shall select methods to achieve the required result without damage to existing project surfaces to remain. Methods for mechanical abrasion include:
   1. Pressure Washing: Use a pressure washer equipped with a fan tip and rated for a minimum pressure capability of 4000 psi (27.5 MPa).
   2. Scrubbing with a rotary floor machine with a Mal-Grit Brush from the Malish Corporation.
   3. Light sanding of the surface.
   4. Other methods approved by the hardening compound manufacturer.

C. Control water to avoid damage to other building materials. Rinse concrete substrates until rinse water is completely clean.

D. Control dust using HEPA filtration equipment approved by the Contractor's competent person in charge of worker safety. Remove dust from surface.

3.03 SURFACE REPAIRS

A. Repair surface defects such as spalls, divots, cracks, unevenness, lippage, etc., in accordance with hardening compound manufacturer's recommendations using products and procedures recommended by hardening compound manufacturer.

3.04 JOINTS

A. Expansion Joints and Contraction Joints: Install joint filler specified in Part 2 of this Section.

B. Install joint filler in freshly prepared joints that have mechanically abraded, open, porous, clean, dust-and-oil-free joint faces.

3.05 HARDENING AND BURNISHING

A. Cured Concrete: Apply hardener only to clean, bare concrete.
   1. Saturate surface with hardener; re-spray or broom excess onto dry spots.
   2. Keep surface wet with hardener for a minimum soak-in period of 30 - 40 minutes.
   3. If most of the material has been absorbed after the 30 minute soak-in period, remove all excess material, especially from low spots, using broom or squeegee.
   4. If most of the material remains on the surface after the 30 minute soak-in period, wait until the surface becomes slippery and then flush with water, removing all cure-seal-hardener residue. Squeegee completely dry, flushing any remaining slippery areas with clean water until no residue remains.

B. Burnishing:
   1. Burnish horizontal surfaces to a uniform satin sheen.

3.06 PROTECTION

A. Protect installed floors for at least 3 months until chemical reaction process is complete.
   1. Do not allow traffic on floors for 3 hours after application.
   2. Do not allow parking of vehicles on concrete slab.
   3. Do not park equipment on slab.
   4. Do not allow pipe cutting on concrete slab.
   5. Do not allow temporary placement and storage of steel members on concrete slabs.
   6. Clean up spills immediately and spot-treat stains with degreaser or oil emulsifier.
   7. Clean floor regularly in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 03 51 19 - GYPSUM CONCRETE ROOF DECK PATCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Patching of gypsum structural roof decking.

1.02 REFERENCE STANDARDS

A. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.

B. ASTM C317/C317M - Standard Specification for Gypsum Concrete; 2000 (Reapproved 2015).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.04 SUBMITTALS

A. Shop Drawings: Indicate layout of slopes, drain locations, and interruptions.

B. Product Data: Provide physical characteristics, thermal values, product limitations.

C. Manufacturer's Installation Instructions: Indicate mix instructions.

D. Installer's qualification statement.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS

A. Gypsum Concrete Patch Material:

1. Basis-of-Design: USG Corporation; USG Securock Brand Gypsum-Concrete Patch www.usg.com/#sle.

2.03 MATERIALS

A. Gypsum Concrete Mix: ASTM C317/C317M.

B. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to gypsum concrete.

2.04 GYPSUM CONCRETE MIX

A. Provide concrete mix with the following minimum properties:

END OF SECTION

SECTION 04 01 20 - MASONRY CLEANING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cleaning existing masonry - The entire building shall be cleaned.

1.02 SUBMITTALS

A. Product Data:
   1. Submit for each cleaning agent (detergent, chemical, etc.).
   2. Submit MSDS for each cleaning agent.
   3. Submit manufacturer's detailed application instructions for proprietary cleaners.

B. Submit a description of proposed protection of surrounding materials on building and Project site, and control of runoff during operations. Describe in detail the materials, methods, and equipment to be used.

C. If materials and methods other than those indicated are proposed for cleaning work, provide a written description, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

D. Trade contractor qualifications.
   1. Trade contractor must have demonstrated proficiency in the restoration of historic properties by the successful performance of work of the nature specified on at least three historic properties in the last ten years, the foregoing installations having been the complete and undivided responsibility of the trade contractor and the work of the foreman proposed for this project. Submit the following:
      a. Name of Foreman and Certificate of Training.
      b. Name, location and description of the three representative projects.
      c. Name and phone number of Owner, Architect and Contractor references for each of the three representative projects.

1.03 QUALITY ASSURANCE

A. Mockups: The mockup process shall be used to determine the cleaning products and methods to be used. The gentlest means possible to clean each condition shall be used. The mockup shall first test the effectiveness of the specified Liquid Detergent, Site-Mixed Detergent-Fungicide and Proprietary Biodegradable, pH neutral, Liquid Cleaning Solution. If these products are not determined to be effective, after review by the Architect, the mockup shall test the effectiveness of the specified Proprietary Liquid Cleaners.
   1. Prepare field samples for cleaning procedures to demonstrate aesthetic effects and qualities of materials and execution. Use materials and methods proposed for completed Work and prepare samples under same weather conditions to be expected during remainder of Work.
   2. Locate mockups on the building where directed by Architect.
   3. Prepare a series of samples representing each of the following surface conditions:
      a. Cleaning of masonry surface.
   4. Mock-up of cleaning to be 3'x3'. Mock-up of coating removal shall consist of one entire element of each type indicated. Mock-up may require multiple applications to achieve acceptable results.
   5. After review by the Architect, prepare additional samples, adjusting materials, methods, timing, etc., as necessary to clean masonry to required finish. Perform mock-up using each cleaning agent specified for each substrate.
      a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions, unless cleaners and methods are known to have a deleterious effect.
      b. Allow a waiting period of not less than 14 days after completion of sample cleaning to permit a study of sample panels for negative reactions.

6. Schedule mock-ups sufficiently in advance of scheduled work to allow for multiple adjustments of mock-up without impacting construction schedule.
7. Obtain Architect's approval of mockups before starting the remainder of restoration and cleaning.
8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

B. It is required that the work of this Section be the responsibility of a single Trade Contractor.

C. Trade contractor: Work must be performed by a firm having not less than 5 years successful experience in comparable masonry restoration projects and employing personnel skilled in the restoration process and operations indicated.

1.04 DEFINITIONS

A. All pressures measured at discharge end.

B. Garden Spray: Spray of hand-pump-up garden-type (“Hudson”) sprayer with nozzle adjusted to a cone-shape. Powered garden-type sprayers providing equivalent spray are also acceptable. Stainless steel or plastic parts required (galvanized not acceptable).

C. Very-Low Pressure Spray: 30 psi (nominal) through a 3/4-inch diameter hose fitted with a nozzle producing a conical spray of approximately 60 degrees applied at a distance not closer than 4 feet from the surface. Provide pressure/volume/cut-off valve at discharge end.

D. Low-Pressure Spray: 100 to 200 psi; 4 to 6 gpm.

E. Medium-Pressure Spray: 200 to 600 psi; 4 to 6 gpm.

F. High-Pressure Spray: 600 to 1200 psi; 4 to 6 gpm.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver other materials to Project site in manufacturer's original and unopened containers, labeled with type and name of product and manufacturer.

B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.06 PROJECT CONDITIONS

A. Clean surfaces only when air temperature is 40 degrees F and above and will remain so for at least 7 days after completion of cleaning.

1.07 SEQUENCING AND SCHEDULING

A. Perform masonry cleaning and restoration work in the following sequence:
1. Remove vegetation adjacent to building that is scheduled to be removed.
2. Install temporary materials where required to prevent entry of water or chemicals into interior of masonry work, windows, doors, louvers, and other openings.
3. Protect from damage windows, doors, louvers, and other openings as well as other non-masonry surfaces that are not to be cleaned. Provide temporary masking of such surfaces where cleaners might damage such surfaces.
4. Clean masonry surfaces.
5. Perform masonry repair and repointing as specified elsewhere in Division 4.

B. Initial Cleaning: Clean existing soil, stains, efflorescence, etc., from masonry prior to demolition and performing repairs.

C. Final Cleaning: Clean masonry when work is complete - required only to the extent that masonry is soiled by construction operations.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 6000 - Product Requirements.

2.02 MATERIALS

A. Water: Clean, potable water.

B. Warm water for mixing cleaning solutions.

C. pH paper with 3 colors to identify numeric pH level.

D. Liquid Detergent: Liquid dish washing detergent such as "Ivory Clear'.
   1. Shall not contain additives (whiteners, brighteners, detergents, fragrance, etc.).

E. Powdered Detergent: Powdered detergent such as "Tide".
   1. Shall not contain additives (whiteners, brighteners, detergents, fragrance, etc.)

F. Trisodium Phosphate:
   1. Strong, base-type, phosphate-containing, powdered cleaning material.
   2. Other chemical or common names include Sodium Orthophosphate; Tribasic sodium phosphate; Trisodium orthophosphate; TSP; Phosphate of soda.
   3. Available from chemical supply house, grocery store, supermarket, or hardware store.
   4. Shall not contain additives (whiteners, brighteners, detergents, fragrance, etc.).

G. Sodium Hypochlorite (NaOCL).
   1. Other chemical or common names include bleaching solution; household bleach; laundry bleach; solution of chlorinated soda.
   2. Available from chemical supply house, grocery store, supermarket, hardware store, or janitorial supply distributor.
   3. Shall not contain additives (whiteners, brighteners, detergents, fragrance, etc.).

H. Proprietary Biodegradable, pH neutral, Liquid Cleaning Solution:
   1. D/2 Biological Solution, www.d2bio.com or (917) 693-7441.

I. Proprietary Liquid Cleaners:
   1. Enviro Klean ReVive; Prosoco, Incorporated.
   2. MasonRE B All Purpose Cleaner; Cathedral Stone.
   3. Envirestore 100TM; Dietrich Technologies.

2.03 MIXES

A. Liquid Detergent:
   1. Mix:
      a. 1/2 fluid ounce liquid detergent.
      b. 1 gallon warm water.

B. Site-Mixed Detergent-Fungicide:
   1. Mix the following until completely dissolved:
      a. 1/3 cup trisodium phosphate cleaner.
      b. 1/3 cup powdered detergent.
      c. 1 qt 5% sodium hypochlorite bleach.
      d. 3 qts. warm water.

C. Proprietary Biodegradable, pH neutral, Liquid Cleaning Solution:
   1. Mix in accordance with manufacturer's instructions.

D. Proprietary Liquid Cleaners:
   1. Mix in accordance with manufacturer's instructions.

2.04 TEMPORARY COVERS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished masonry surfaces from the damaging effects of acidic and alkaline masonry cleaners.

B. Polyethylene Sheet.

C. Adhesive Tape: Non-staining, leaving building surface residue-free after tape is removed.

2.05 EQUIPMENT

A. Cleaner Sprayer: Very low pressure pump sprayer such as a garden sprayer.

B. Water Sprayer: Very low pressure sprayer (hose and nozzle) or very low pressure power assisted sprayer.

C. Natural or nylon bristle brushes. Metal not permitted.

D. Wood or plastic scrapers. Metal not permitted.

E. Other equipment as necessary for the Work.

PART 3 EXECUTION

3.01 PROTECTION

A. The Building: Where cleaners and rinses have not been demonstrated to be non-deleterious to non-masonry portions of the building, provide temporary masking of non-masonry surfaces.

B. Control of Runoff:
   1. Do not allow cleaners and rinses to collect, pond, or form soft muddy conditions at the base of the building that do not dissipate within 24 hours.
   2. Provide temporary gutters, diversions, collection basins, pumps, and piping if necessary to direct excess liquid to approved discharge points.

C. Protection of Vegetation: A portion of the existing plant life is indicated elsewhere in the Contract Documents to remain. Do not allow cleaners and rinses to contact vegetation to remain.

D. If inadvertent spills of cleaner contact vegetation or other building elements, rinse immediately with potable water until free of cleaner.

E. Do not apply sprays during windy conditions sufficient to carry overspray into contact with other surfaces, vegetation, or people.

3.02 CLEANING STANDARD REQUIRED:

A. General:
   1. Clean using products and procedures established through the mockup process.
   2. Clean masonry to remove mildew, fungus, lichens, algae, dirt, soot, and other forms of soiling without damage to masonry (whether visually apparent or not) and without change in appearance of clean masonry (whether color, texture, polish, finish, etc.) other than removal of the soil.
   3. Clean masonry to remove paint and other coatings, if present.
   4. Degree of cleanliness in the Work shall match that achieved in the approved mock-ups.

3.03 CLEANING, GENERAL

A. Identify “panels” of the building to be cleaned sequentially.

B. Proceed within each panel from the base of the building to the top, unless otherwise approved.

C. Prewetting:
   1. As cleaning proceeds upwardly, maintain lower portions and immediately adjacent portions continuously wet and streak-free and soil-free.
   2. Extend the wetted area horizontally beyond the immediate area to be cleaned.
   3. Wet the area beneath the area to be cleaned, from grade level up to the area to be cleaned.
   4. Maintain these adjacent areas wet with water until rinsing is complete to avoid streaking and deposition of cleaners and residues onto adjacent surfaces.

D. Thoroughly remove cleaners by rinsing with potable water. A final rinse shall be performed from the top of the building down to the base of the building.

E. Clean masonry surfaces in a uniform manner. Include flat surfaces, cornices, moldings, ornament, recesses, tops and undersides, etc., to produce a uniformly clean result.

F. Do not apply different cleaners on a given area unless the cleaner used previously has been thoroughly washed away.

G. Adjustments to meet Project Conditions:
   1. Repeat cleaning procedures or adjust dwell times or adjust the amount or type of scrubbing effort or adjust concentration of cleaners (or a combination the preceding), depending upon the amount and type of soil or stain present on the various parts of the building, and so as to achieve a uniformly clean result and without change in Contract Time or Price.
   2. Obtain the Architect's approval of such adjustments.
   3. Do not exceed concentrations or dwell times or repeat procedures beyond the limits specified or approved by the Architect.

3.04 SPRAYS

A. Do not use power-assisted spray without the written authorization of the Architect.

B. Provide very low pressure spray, taking water from hose bibbs to portions of the building required to be cleaned.

C. If the Architect determines that unassisted pressure at hose-end from the building water supply does not provide adequate pressure or volume, provide power-assisted spray adjusted to simulate very-low pressure spray without change in Contract Time or Price. Obtain the written authorization from the Architect.

D. If the Contractor so requests and the Architect determines that due to remote location or configuration or other Project factors, it is impracticable to use hoses to rinse selected portions, provide power-assisted spray adjusted to simulate very-low pressure spray without change in Contract Time or Price. Obtain the written authorization from the Architect.

3.05 APPLICATION OF LIQUID CLEANERS

A. Remove as much plant growth as possible using a knife blade and stiff bristle brush. Dry-brush the surface before wetting to remove bulk growth.

B. Pre-wet the area to be cleaned (and the adjacent areas) with a water spray.
   1. Extend the wetted area horizontally beyond the immediate area to be cleaned.
   2. Wet the area beneath the area to be cleaned, from grade level up to the area to be cleaned.
   3. Maintain these adjacent areas wet with water until rinsing is complete to avoid streaking and deposition of cleaners and residues onto adjacent surfaces.

C. Apply the solution to the affected area using either a garden spray or medium-stiff natural bristle brush. Use large, flat brushes for flat areas; use small brushes to access recesses, reveals, and detail of ornament.
   1. Scrub with a natural or artificial bristle brush and allow to dwell as necessary depending on degree of soiling and application temperatures.
   2. Dwell times are estimated to be 20 to 30 minutes between 40 and 70 degrees F, and 10 to 15 minutes at 70 degrees F and above, but may range up to an hour or longer depending upon degree of soiling, scrubbing effort, and other factors. Consult manufacturer for required dwell time for the product being used.
   3. Do not allow cleaners to dry out. Reapply cleaner or mist with water to keep the surface saturated, and scrub periodically until the growth, stain, or soil is removed.

D. After-Wash:
   1. Thoroughly rinse cleaner from surface with low-pressure spray water.
   2. Immediately apply after-wash to surface and allow to dwell for 3 to 5 minutes.

E. Thoroughly rinse the surface with low-pressure spray water.

1. Test liquid rinse run-off drops with pH paper to ensure that ensure that cleaning solutions have been effectively removed. Continue rinsing until pH is neutral. (pH testing of liquid detergent is not required or effective.)
2. Allow to dry.
3. Test as often as necessary to ensure reliable, repeatable results and when otherwise requested by the Architect.

F. Use prepared solutions within 24 hours.

3.06 REMOVAL OF POST-CLEANING EFFLORESCENCE

A. If a light dusting of efflorescence appears after the cleaning, remove the efflorescence by dry brushing with a clean brush. If dry brushing is not completely successful, wet the surface with water and brush to remove the efflorescence.

3.07 COATING REMOVAL

A. Perform all work in accordance with manufacturer's instructions for each product specified.

END OF SECTION

SECTION 04 09 20 - MASONRY REPLACEMENT, REPAIR AND RE-POINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Removing anchors.
   2. Re-pointing mortar joints in brick masonry, between brick masonry and stone masonry elements.
   3. Coordinating with structural design for new lintels and helical wall ties.
   4. Removal, replacing and/or resetting of loose or damaged masonry.
   5. Dismantling and reconstruction of existing masonry.
   6. Filling holes with compatible and matching brick and mortar.
   7. Replacement brick for the historic buildings.

1.02 REFERENCES

A. CEN EN 459 - Building Lime - Part 1: Definitions, Specifications and Conformity Criteria; 2015.

B. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar

C. ASTM C 150 - Standard Specification for Portland Cement

D. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.

E. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

1.03 SUBMITTALS

A. Product Data:
   1. Replacement Brick
   2. Hydrated Lime:
      a. Product data sheets.
      b. Manufacturer’s storage and shipping requirements information.
      c. Manufacturer’s climate requirements for installation and curing.
   3. Slag cement
      a. Product data sheets.
   4. Aggregate (sand):
      a. Sieve analysis.
      b. Aggregate void ratio.
      c. Description of screening process.

B. Trade contractor qualifications.
   1. Trade contractor must have demonstrated proficiency in the restoration of historic masonry by the successful performance of work of the nature specified on at least three historic properties in the last ten years, the foregoing installations having been the complete and undivided responsibility of the trade contractor. Trade contractor shall submit the following:
      a. Name of Foreman.
      b. Names of individual masons performing raking, re-pointing, and finishing operations.
      c. Certificate of Training and experience fof each mason and foreman.

C. Samples:
   1. Replacement brick to match existing.
   2. 1-cup sample of screened aggregate.
   3. Mortar samples: 6” long by ½” wide sample strips of each mortar mix specified, set in aluminum or plastic channels. Provide record of mortar mix, composition and field procedures to be followed.
   4. Samples of historic materials for comparison:

a. Provide sample of existing mortar, extracted at same location as sampled mortar. Sample size approximately 3" long x 2" deep.
b. Provide sample of screened aggregate from historic mortar. Sample to be approximately 1/4 cup.

1.04 MOCK-UPS

A. Perform mock-ups in situ in a location selected by the Architect. Perform mock-ups of each type of repair and repointing specified, including but not limited to:
1. Joint excavation, including cleaning of mortar bond surfaces.
2. Shallow (up to 1/2" deep) repointing.
3. Deep (exceeding 1 1/2" deep or multiple lifts) repointing.
4. Filling small holes with mortar.
5. Installation of helical ties above window and in as many configurations as specified by the structural drawings.
6. Mortar color matching with existing mortar. Provide samples first of the approved mortar mix an then provide 4'x8' mock up on the building as directed by Architect. The 4'x8' area shall be cleaned properly and acceptable to Architect prior to performing the mock up of the mortar. Modify mix as needed until color is acceptable to Owner and Architect at no additional charge to Owner. Mock-up to show sequencing step of removal, presparation of joint and lift installation.

B. See additional trade contractor mock-up requirements per Quality Assurance below.

1.05 QUALITY ASSURANCE

A. It is required that the work of this Section be the responsibility of a single Trade Contractor.

B. Trade contractor: Work must be performed by a firm having not less than 10 years successful experience in comparable masonry restoration projects and employing personnel skilled in the restoration process and operations indicated.

C. Masons:
1. Raking, re-pointing, removal, material salvage, and finishing operations shall be performed by craftspeople familiar with historic mortar formulations, curing conditions, and performance characteristics. Contractor shall provide proof of such knowledge by providing a list of completed, comparable projects.
2. Only skilled journeymen masons who are familiar and experienced with the materials and methods specified and are familiar with the design requirements shall be used for masonry restoration.
3. One skilled journeyman mason shall be present at all times during masonry restoration and shall personally direct the work.
4. The masons performing stone patching must be experienced and certified by the manufacturer in the proper application and use of the product.

D. Trade contractor Mock-ups:
1. Every mason shall construct a mock-up for each activity that they will perform. Only masons who have demonstrated proficiency in a task per the approval of the Architect shall be permitted to perform that particular task.
2. Mock-ups shall be witnessed by the Architect.
3. Obtain Architect’s approval of mockups before starting the remainder of the work.
4. Retain approved mock-ups in undisturbed condition, suitably identified, during restoration as a standard for judging completed work.

E. Approvals:
1. Approved samples and mock-ups may remain as a part of permanent work, if approved by Architect.
2. Obtain approval of raking out and surfaces preparation before finishing joints.
3. Final viewing of finished joints for approval will occur approximately 30 days after finishing.

4. For approval of finished appearance, joints will be viewed from a distance of 8 feet, except in areas naturally seen from close proximity, or as the scaffold configuration allows.
5. Approval of technical considerations in joint construction is not limited by viewing distance.
6. All identified bond failures or areas of notable cracking shall be removed and repointed.

PART 2 - PRODUCTS

2.01 BRICK AND STONE

A. Submit new replacement brick for approval. Bricks with product data including moisture and vapor transmission are preferred.

2.02 MORTAR MIXES

A. Mortar Mix - Type O as Basis of Design or an NHL 3.5 mortar
   1. Potable water to mix.

B. Hydraulic Hydrated Lime:
   1. Manufacturers:
      a. Preservation Works, LTD: www.preservationworks.us/#sle.
      b. Saint Astier; _____: www.stastier.com/#sle.
      c. U.S. Heritage Group, Inc: usheritage.com/#sle.
   2. Comply with European Norm CEN EN 459.
      a. Strength Classification: NHL 3.5 - moderately hydraulic lime.

C. Job mixing
   1. Mix sand and lime thoroughly by hand before adding water. Add water very carefully so as to achieve a peanut butter type consistency. Do not add too much water.
   2. Allow mix to set for approximately 15 minutes until desired consistency is achieved.
   3. Addition of admixtures, including antifreeze ingredients, will not be permitted.
   4. Measure materials for job-mixed mortars in a one cubic foot container. Do not measure by shovels.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with trade contractor present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

B. Do not proceed until unsatisfactory conditions have been corrected. Once the trade contractor begins work he has accepted all conditions and shall bear the cost of any later corrections required by unsatisfactory conditions.

C. Before removing any deteriorated work establish bonding patterns, levels, and coursings.

3.02 PROTECTION

A. Prior to commencing masonry work assemble sun and wind protection assembly. Keep assembly in place until the completion of curing.

B. Prevent mortars and grouts from staining the face of masonry or other surfaces to be left exposed immediately. Remove mortars and grouts that come in contact with such surfaces.

C. Cover partially completed work with moistened burlap when work is not in progress to prevent premature curing of the mortar. Keep burlap moist.

D. Protect sills, ledges and projections from droppings.

E. Secure burlap with wood shims in existing joints. Do not use tapes or adhesive on any masonry surface.

F. Protect new work per “ Curing”, below.

3.03 TEMPORARY SHIM SUPPORT

A. Provide temporary supports where necessary to prevent displacement of masonry during re-pointing and until mortar has achieved sufficient strength.

B. Notify Architect of need for temporary support and provide mock-up of temporary support.

3.04 REMOVING ANCHORS

A. Small anchors, nails, and pins have been driven into the masonry at various locations. Remove all as a part of this contract and discard anchors, nails, pins, and similar devices. This includes all air conditioning brackets; previous window anchorage and light fixtures.

B. Remove ferrous material completely. Do not allow portions to remain embedded unless they are existing wall ties. Existing wall ties are believed to be galvanized metal.

C. Where brittle materials cannot be pulled out intact, remove remaining embedded material by drilling. Point hole with mortar.

3.05 REPOINTING BRICK MASONRY

A. Removing Existing Mortar from Joints:
   1. There is limited pointing in areas where cracking occurs. Limit area to repoint All existing cement mortar must be carefully removed by a skilled mason. The mortar in head and bed joints shall be removed to the required depth using hand or pneumatic stone carving chisels. Grinders are permitted for removing mortar from bed joints ONLY. Do not use grinders to remove mortar from head joints.
   2. Raking out shall leave a clean, square face of sound mortar at the back of the joint, and clean masonry surfaces. Shallow or feather edging will not be permitted.
   3. Do not widen the existing masonry joints. Do not spawl or chip the surrounding masonry edges in the process of mortar removal. Damage to masonry shall not be permitted. Trade contractor shall replace all brick damaged during mortar removal. Damaged brick shall be replaced by removing and reversing same brick.
   4. Brush joint faces and blow out debris from joint with pressurized air to remove dirt and loose debris, working from top to bottom of wall.
   5. When substantially complete with joint excavation, thoroughly rinse debris from joints and saturate the masonry. This step clears dust and debris and allows better evaluation of the joint excavation.
   6. Remove remaining mortar to required depth and rinse again.
   7. A/E may inspect joint excavation and surface preaparation. Provide access for A/E inspections. Lead mason shall inspect joint excavation and ensure that joints are ready for repointing.

B. Mortar Removal Depth:
   1. Existing mortar joints where repointed shall be raked out to whichever depth is greatest:
      a. 1 inch
      b. 2-1/2 times the width of the existing mortar joint.
      c. Until bonded, cohesive existing mortar is encountered.

C. Removing Mortar Excess from Masonry Faces:
   1. Existing excess mortar from prior masonry work and excess mortar from the work of this contract shall be removed from the faces of the masonry using the gentlest means possible.
   2. Existing excess mortar from prior masonry work shall be carefully picked off taking care not to damage the host masonry. If the mortar cannot be removed from the face of the host masonry without damage, then the mortar shall be left in place, if approved by the Architect.

D. Prewetting:
   1. Brush joint faces and flush out joints with water to remove dirt and loose debris, working from top to bottom of wall. Rinse stone joints with water to remove dust and mortar particles. Thoroughly wet wall below to avoid soiling. Time the rinsing application so that at

the time of pointing excess water has evaporated or run off. Joint surfaces should be damp but free from standing water.

2. Prior wetting is necessary to achieve the proper absorption rate before masonry repair commences and is essential to good masonry practice. Presoak walls and joints with water as required by project and weather conditions. During hot or windy weather, wet walls and joints several times in advance of pointing. Re-wet walls and joints yet to be pointed if masonry dries out before pointing. Masonry units shall be damp but without standing water at the time of pointing.
3. Maintain hand mister bottles or a garden sprayer with clean, clear, potable water immediately available to masons at all times during the re-pointing process. A very low-pressure spray (garden hose with nozzle adjusted to a fine, low-volume mist) may be used over large areas providing erosion of joints is prevented.
4. Exposed surface of masonry adjacent to joint shall be wet prior to re-pointing.

E. Re-pointing of Mortar Joints:
1. Joints shall be pointed in layers or "lifts" .
   a. Joints shall be pointed with an initial lift to bring the joint depth to a uniform depth.
   b. Compress each layer at the time it is placed in the joint by applying firm pressure with the pointing tool.
   c. Allow each lift to become thumbprint hard before applying the next lift.
2. Finishing Joints, General: Tool the joint to match the historic joints. Joints to be a flush profile set back from the face of brick by a minimum of 1/16 inches as approved in the site mock up.
3. Tooling: Concave joint.
4. Finish joints uniformly. Do not overwork. Leave the surface of the masonry clean.

3.06 REMOVAL AND RESETTING OF LOOSE OR DAMAGED BRICK

A. Removal and reinstallation of loose bricks:
1. Remove brick that is not fully adhered to the surrounding mortar.
2. Clean all mortar from adjacent bricks still firmly adhered per “Removing Existing Mortar” and “Removing Mortar Excess from Masonry Faces” in “Repointing” section above.
3. Clean all mortar from removed brick(s) per “Removing Mortar Excess from Masonry Faces” in “Repointing section above.
4. Pre-wet bricks per “Prewetting” in “Repointing section above. Soak replacement brick for a minimum of two hours in water until used in masonry work.
5. Re-set bricks in original location. If bricks are damaged or broken during removal process, replace damaged brick by reversing same brick. Only if existing brick is too damaged to reverse and reuse, should replacement brick be used.

3.07 DISMANTLING AND RECONSTRUCTION OF EXISTING MASONRY

A. Preparation:
1. Prior to dismantling masonry, photographically document existing conditions to record bonding pattern, sizes, relationships and appearance. Replacement of the wall shall be done so that the wall looks the exact same as when removed. Provide documentation and indicate coursing, any stepping patterns of the brick and bond pattern to Architect.
2. Ensure that shoring and other protective measures are adequate to stabilize unstable masonry.
3. Salvage all soldier course brick at top floor header for resue. The bricks on the building are not a standard size and it will be particularly difficult to rebuild this portion of the wall without salvaging brick. To repair the headers all bricks must be salvaged until determined they are no longer needed.
4. Contractor shall mix old and new brick if necessary and feasibile and with the consent and direction of the architect to insure a repair that is acceptable. Sizes of the brick may prevent this. While it is the intent of the project to reuse as much brick as possible, the contractor shall plan for enough and include in pricing enough brick to replace entire areas shown on drawings for full replacement.

5. Wet brick having absorption rates greater than 0.025 ounce per square inch per minute.
   a. Absorptive brick shall be thoroughly soaked each afternoon prior to the day they are to be used.
   b. Cover bricks to prevent evaporation.
   c. Wet brick as necessary during the day. Sprinkle with hose for a period long enough for water to run down the side of the brick pile. Use wetting methods that ensure that each brick is nearly saturated but surface dry when laid.
6. Where fresh masonry adjoins existing work, clean the exposed surface of the set masonry by removing loose brick and mortar and wet lightly to obtain the best possible bond with the new work.

B. Dismantling and Cleaning:
1. Carefully dismantle existing exterior wythe of wall.
2. Document interior bond pattern during dismantling process and photograph. Maintain photographic records.
3. Exercise care with masonry. Loosen joints and adhesions with hand or pneumatic chisels. Do not break masonry units.
4. Remove masonry units one at a time.
5. Carefully remove bond bricks from intact masonry. Clean all remaining joint faces in cavity left by bond brick.
6. Soak all removed masonry for a minimum of 24 hours before cleaning.
7. Carefully remove mortar with hand or pneumatic chisels.
8. Protect and maintain existing brick to remain by stacking and storing clean bricks on pallattes for protection and reuse. Do not pile bricks in heap. Cover bricks to be reinstalled with tarps or plastic.
9. Notify architect when removal of large portions of exterior wythe masonry is complete for inspection of the substrate.

C. Reconstruction:
1. Rebuild back-up and substrate as required to replace any unsound material that was removed. See drawings.
2. Clean the cavity of loose mortar and other debris by hand using a chisel and stiff bristle brush.
3. Lightly wet the exposed brick surfaces.
4. Soak removed and replacement brick for a minimum of two hours in water until used in masonry work.
5. Re-set bricks in original location. If bricks are damaged or broken during removal process, replace damaged brick by reversing same brick. Only if existing brick is too damaged to reverse and reuse, should replacement brick be used.
6. Lay brick units with completely filled collar bed and head joints. Butter ends with sufficient mortar to fill head joints and shove into place.
7. Lay masonry plumb and true following the coursing, patterns and joint size of the adjacent existing sound construction.
8. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.
9. Blend new work into existing work smoothly with no lines of demarcation and no change of pattern or coursing.
10. Rake all joints in replacement work to receive tuck pointing. Joints up to 3/8” in width shall be raked to a depth of ½”. Joints 3/8” in width or greater shall be raked to a depth of 1”.
11. Tuck point joints per “Repointing of Masonry Joints” above.
12. Brush all excess mortar from surfaces frequently during the work. Protect all existing surfaces from mortar dripping and splashing.

3.08 CLEANING

A. Maintain clean surfaces on the face, sills, ledges, and projections of masonry on a daily basis.

B. With a trowel, strike off minor dabs of adherent mortar from face of masonry.

C. Remove minor mortar marks from masonry by misting with water and brushing with a small, stiff-bristle brush every day. Do not allow mortar to set on face of brick for more than 4 hours.

3.09 CURING

A. Keep mortar from drying out too quickly.

B. Mist walls with water as required by project and weather conditions to insure slow curing of the mortar. Freshly pointed mortar shall be maintained as described below. From the eighth to the thirtieth day, mortar shall be misted 3 times daily.

C. Apply water to the re-pointed joints and adjacent masonry in a fine, low-volume mist with a garden spray; avoid washing out fresh mortar.
   1. During mild weather thoroughly dampen the surface of the wall 3 times per day (early morning, noon, mid-to-late afternoon) for the 2 days following the day of installation.
   2. Ensure that dampening occurs on schedule including Saturdays, Sundays, and holidays.
   3. During hot or windy weather dampen more frequently.

D. Protect freshly pointed areas with damp burlap and fine mist spray for the first seven days after installation. Keep burlap clean.

END OF SECTION

SECTION 04 20 00 - UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Clay or Shale Facing Brick.
   2. Common Brick.
   3. Architectural cast stone.
   4. Mortar and Grout.
   5. Reinforcement and Anchorage.
   6. Accessories.

B. Products Installed but not Furnished Under this Section, Including, but not Limited to:
   1. Items specified elsewhere and which are built into masonry.
   2. Lintels.
   3. Frames for openings.
   4. Anchors for built-in items.
   5. Inserts and connectors.
   6. Utility items.

1.02 REFERENCES

A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).

B. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement; 2019.

C. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2018a.

D. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement; 2019, with Editorial Revision (2020).

E. ASTM C1364 - Standard Specification for Architectural Cast Stone; 2019.

F. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.

G. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).

H. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2016.

I. ASTM A580/A580M - Standard Specification for Stainless Steel Wire; 2018.

J. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

K. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

L. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

M. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2018.

N. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale); 2022.

O. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

P. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale); 2017.

Q. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2017.

R. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.

S. “Standard Practice for Bracing Masonry Walls Under Construction”, Council for Masonry Bracing.

1.03 DEFINITIONS

A. As listed in TMS 402/602.

B. “To match existing building”: No visible difference when viewed by the Architect as specified under “Appearance of Completed Masonry” at the end of this Section. The Architect’s approval of initial product submittals, sample panels, etc., is preliminary only. Final approval shall be on the basis on in-place mock-ups and permanent work.

1.04 SUBMITTALS

A. Product Data:
   1. Masonry units.
   2. Architectural cast stone.
   3. Cementitious materials.
   4. Joint reinforcement.
   5. Anchors.
   6. Accessories.

B. Other Product Data - Test Reports:
   1. Sand: Sieve analysis and aggregate void ratio. Perform test not more than 60 days before date of submittal.
   2. Mortar:
      a. Mix design: Proportions of each material by volume.
   3. Grout Mix Design:
      a. Proportions of each material.
      b. Compressive strength test results.

C. Shop Drawings:
   1. Specially shaped units.
   2. Sizes, locations, and fabrication dimensions of reinforcing steel.
   3. Design data for engineered veneer anchors:
   4. For veneer anchors used in cavities larger than 4.5 inches (115 mm), submit design data prepared by the veneer anchor manufacturer demonstrating that anchors comply with the requirements of the Building Code / TMS 402/602; design data shall bear the seal of a professional engineer licensed to practice in the State in which the Project is located.

D. Office Samples:
   1. Mortar: 2 inches (50 mm) samples.
   2. Masonry units demonstrating full range of color and texture.

E. Proposed hot and cold weather procedures.

F. Cast Stone Manufacturer's Qualification Data: Documentation showing compliance with specified requirements.

G. Installer's qualification statement.

1.05 BRICK AND MORTAR SAMPLE PANELS

A. Where new work is specified to match existing:
   1. Prepare 3 large and 3 small sample panels demonstrating a range of proposed mortar color and masonry units.
   2. Construct panels on site in a location designated by the Architect.
   3. Panel Size:
      a. Fixed: 4 feet (1.2 m) high by 4 feet (1.2 m) wide.
      b. Portable: 5 courses high by 2 feet (0.6 m) wide with strapping for handling.

4. The appearance of mortar, joint work, and masonry units in the sample panels shall match the appearance of the existing when evaluated by the Architect in accordance with “Appearance of Completed Work” at the end of this Section.

B. If a sample panel is not approved, make appropriate adjustments and construct additional panels.

1.06 QUALITY ASSURANCE

A. Face Brick Manufacturer Qualifications:
   1. A firm with a minimum of 5 years experience producing face brick of types and sizes required for project.

B. Cast Stone Manufacturer Qualifications:
   1. A firm with a minimum of 5 years experience producing cast stone of types required for project.
   2. Current producer member of the Cast Stone Institute or the Architectural Precast Association.
   3. Adequate plant capacity to furnish quality, sizes, and quantity of cast stone required without delaying progress of the work.

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 MOCK-UP

A. Construct mock-ups in the presence of the Architect.

B. Mock up each type of masonry work and obtain the Architect's approval before proceeding with full production.

C. Include the following:
   1. Foundation.
   2. All components of back-up.
   3. Studs.
   4. Sheathing.
   5. Weather resistant membrane or barrier.
   6. Insulation.
   7. Anchors.
   8. Veneer.
   9. Window.
   10. Lintel.
   11. Flashing with end dams, cleanouts, and weeps.

D. Construct mock-ups on separate, temporary foundations in locations on the site identified by the Architect.
   1. Mock-ups shall not remain as a part of permanent work. Remove from the site when directed by the Architect.

1.08 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Do not allow materials to become damaged or contaminated by other materials.

B. Masonry Units: Provide on-site storage of masonry units required for not less than 4 weeks production.
   1. Store units raised above ground on pallets or similar flooring to prevent moisture pick-up.
   2. Store units under cover to prevent moisture pick-up from rain or snow.
   3. Do not tarp or wrap units so as to trap moisture or to permit condensation to form.
   4. Allow air to circulate freely around units.
   5. Use only masonry units that have been stored thus for not less than 3 weeks.

C. Cast Stone:
   1. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
   2. Number each piece individually to match shop drawings and schedule.
   3. Store cast stone components and installation materials in accordance with manufacturer's instructions.
   4. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.

D. Sand:
   1. Maintain sand at a constant moisture content.
   2. Cover pile when not in use.
   3. Arrange pile for free drainage.
   4. Do not use the bottom portion of the pile (wet or in contact with earth) in mortar.
   5. At Contractor's option use bagged, kiln-dried sand.

E. Cement and Lime:
   1. Store materials raised above ground on pallets or similar flooring to prevent moisture pick-up.
   2. Store materials under cover to prevent moisture pick-up from rain or snow.
   3. Do not tarp or wrap materials so as to trap moisture or to permit condensation to form.
   4. Allow air to circulate freely around units.
   5. Do not use bags that have been broken or exposed to moisture.

F. See additional requirements under “In-Progress Cleaning” at the end of this section.

1.10 PROJECT SITE CONDITIONS

A. Cold Weather Requirements. When either the ambient air temperature or the temperature of masonry units is below 40 deg F. (4.5 deg C.):
   1. Submit proposed procedures to the Architect.
   2. Materials:
      a. Ensure that temperature of masonry units is greater than 20 deg F. (- 6.5 deg C.) when laid in the masonry.
      b. Remove visible ice from masonry units before laying in the masonry.
      c. Heat mortar sand or mixing water to produce mortar temperatures between 40 deg F. (4.5 deg C.) and 120 deg F. (49 deg C.) at the time of mixing. Maintain mortar above freezing until used in masonry.
   3. Protection when laying masonry:
      a. Use heat sources when ambient temperature is between 20 deg F. (- 6.5 deg C.) and 25 deg F. (-4.0 deg C.) on both sides of the masonry under construction.
      b. Provide wind breaks when wind velocity is in excess of 15 mph (24 km/hr).
      c. When ambient temperature is below 20 deg F (- 6.5 deg C), provide temporary enclosure for the masonry under construction and provide temporary heat to maintain temperature above 32 deg F (0 deg C) within the enclosure.
   4. Protection after laying masonry:
      a. When mean daily temperature (average of high and low) is between 32 deg F (0 deg C) and 40 deg F (4.5 deg C), protect completed masonry from rain or snow by covering with a weather-resistant membrane for 24 hours after construction.
      b. When mean daily temperature (average of high and low) is between 25 deg F (-4.0 deg C) and 32 deg F (0 deg C), completely cover completed masonry with a weather-resistant membrane for 24 hours after construction.
      c. When mean daily temperature (average of high and low) is between 20 deg F (- 6.5 deg C) and 25 deg F (-4.0 deg C), completely cover completed masonry with insulating blankets for 24 hours after construction.
      d. When mean daily temperature (average of high and low) is below 20 deg F (- 6.5 deg C), maintain the temperature of masonry above 32 deg F (0 deg C) for 24 hours after

construction by providing temporary enclosure with temporary heat, by providing electric heating blankets or infrared heat lamps, or by other approved methods.

B. Hot weather construction.
   1. Submit proposed procedures to the Architect.
   2. Preparation. The following requirements shall be met prior to conducting masonry work.
      a. Temperature. When the ambient temperature exceeds 100 deg F (38 deg C), or exceeds 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h) :
         1) Necessary conditions and equipment shall be provided to produce mortar having a temperature below 120 deg F (49 deg C).
         2) Sand piles shall be maintained in a damp, loose condition.
      b. Special conditions. When the ambient temperature exceeds 115 deg F (46 deg C), or 105 deg F (40 deg C) with a wind velocity greater than 8 mph (13 km/h), observe the above requirements and in addition, provide shade so that direct sunlight does not fall on materials and mixing equipment.
   3. Construction. The following requirements shall be met while masonry work is in progress.
      a. Temperature. When the ambient temperature exceeds 100 deg F (38 deg C), or exceeds 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h):
         1) The temperature of mortar and grout shall be maintained below 120 deg F (49 deg C).
         2) Mixers, mortar transport containers and mortar boards shall be flushed with cool water before they come into contact with mortar ingredients or mortar.
         3) Mortar consistency shall be maintained by retempering with cool water. Do not retemper colored mortar to the degree that variations in color are apparent in the completed masonry.
         4) Mortar shall be used within 2 hours of initial mixing.
      b. Special conditions. When the ambient temperature exceeds 115 deg F (46 deg C), or exceeds 105 deg F (40 deg C) with a wind velocity greater than 8 mph (13 km/h), observe the above requirements and in addition cool mixing water used for mortar and grout. The use of ice shall be permitted in the mixing water prior to use. Ice shall not be permitted in the mixing water when added to the other mortar or grout materials.
   4. Protection. When the mean daily temperature exceeds 100 deg F (38 deg C), or exceeds 90 deg F (32 deg C) with a wind velocity greater than 8 mph (13 km/h), newly constructed masonry shall be fog sprayed until damp at least three times a day until the masonry is three days old.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 CLAY OR SHALE MASONRY UNITS

A. Face Brick: ASTM C216.
   1. Average net area compressive strength of units, ASTM C67: At least 4,150 psi (28.6 MPa).
   2. Grade SW.
   3. Color and texture: Match existing brick.

B. Building (Common) Brick: ASTM C62.
   1. Average net area compressive strength, ASTM C67: 4,150 psi (28.6 MPa).
   2. Grade _____

C. Nominal Size: 4 inches (100 mm) by 8 inches (200 mm) by 2-2/3 inches (65 mm).

D. Provide specially extruded or molded units where specially shaped units are required by project conditions.

1. Special shapes sawn from standard units will be permitted where the sawn face is not exposed to view or to weather.

2.03 ARCHITECTURAL CAST STONE

A. Cast Stone: Architectural concrete product manufactured to simulate appearance of existing natural limestone, complying with ASTM C1364.
   1. Compressive Strength: As specified in ASTM C1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
   2. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ASTM C1364.
   3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet (6 meters).
   4. Color: Match existing.
   5. Remove cement film from exposed surfaces before packaging for shipment.

B. Shapes: Provide shapes indicated on drawings.
   1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch (3 mm) or length divided by 360, whichever is greater, but not more than 1/4 inch (6 mm).
   2. Unless otherwise indicated on drawings, provide:
      a. Wash or slope of 1:12 on exterior horizontal surfaces.
      b. Drips on projecting components, wherever possible.
      c. Raised fillets at back of sills and at ends to be built in.

C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI CODE-318.
   1. Pieces More than 24 inches (610 mm) in Any Dimension: Provide full length two-way reinforcement of cross-sectional area not less than 0.25 percent of unit cross-sectional area.

D. Materials:
   1. Portland Cement: ASTM C150/C150M.
      a. For Units: Type I, white or gray as required to match Architect 's sample.
      b. For Mortar: Type I or II, except Type III may be used in cold weather.
   2. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
   3. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
   4. Pigments: ASTM C979, inorganic iron oxides; do not use carbon black.
   5. Admixtures: ASTM C494/C494M.
   6. Water: Potable.
   7. Reinforcing Bars: ASTM A615/A615M, Grade 40 (40,000 psi) (280 MPa), deformed bars, galvanized.
      a. Galvanized in accordance with ASTM A767/A767M, Class I.
   8. Steel Welded Wire Reinforcement: ASTM A1064/A1064M, galvanized or ASTM A884/A884M, epoxy coated.
   9. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.
   10. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

E. Producers:
   1. Any current producer member of the Cast Stone Institute.

2.04 MORTAR MATERIALS

A. Deliver cementitious materials to the job site in bags containing factory proportioned quantities of cement, lime, and pigment in each bag according to the approved design mix, unless an alternate method of batching is approved by the Architect. Manufacturer's label on each bag shall clearly indicate compliance with this specification. Labels bearing the words “masonry cement” shall in addition bear the words “Portland-lime” or other clear indication of compliance with this specification.

B. Portland Cement: ASTM C150/C150M, Type I.
   1. For exposed masonry provide white cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

C. Masonry Cement and Mortar Cement are not acceptable.

D. Hydrated Lime: ASTM C207, Type S.

E. Mortar Aggregate: ASTM C144.

F. Pigments for Colored Mortar: Iron or chromium oxides with demonstrated stability and colorfastness and complying with ASTM C979/C979M.
   1. Provide color matching the existing mortar color after existing mortar has been cleaned.

G. Water: Clean and potable.

2.05 REINFORCING AND ANCHORS

A. The manufacturers specified herein have standard or made-to-order veneer anchors of sufficient strength to meet the Project requirements. Provide anchor thickness/gauge as necessary to meet the required loads but in no case less than that specified below. For veneer anchors used in cavities larger than 4.5 inches (115 mm), make arrangements with the veneer anchor manufacturer to provide anchors of the type specified and of the necessary thickness and strength to comply with the requirements of the Building Code / TMS 402/602, and submit design data bearing the seal of a professional engineer licensed to practice in the State in which the Project is located.

B. For the materials below, provide products of one of the following:
   1. Blok-Lok.
   2. Heckmann.
   3. Hohmann & Barnard (H & B).

C. For the joint reinforcing and anchoring products below, provide the following material:
   1. Exterior walls (all wythes):
      a. Stainless steel ASTM A580/A580M, Type 304.

D. Masonry Veneer Anchors:
   1. Sized for embedment into veneer at least 1-1/2 inch (40 mm) and extending not closer than 5/8 inch (16 mm) from the exposed face.
   2. Clearance between tie and base parts: Not more than 1/16 inch (2 mm).
   3. Over stud back-up: Single screw anchor with two-leg anchor. Provide length of screw-barrel assembly to match the thickness of continuous insulation in the masonry cavity and to ensure a snug, compression of the insulation against the wall back-up.
      a. Blok-Lok Thermal Concrete 2-Seal Wing Nut Anchor (wood stud, CMU, concrete backup); Thermal 2-Seal Wing Nut Anchor (steel stud backup).
      b. Heckmann #75TC Pos-I-Tie ThermalClip with CI washer.
      c. H & B Thermal Concrete 2-Seal Wing Nut Anchor (wood stud, CMU, concrete backup); Thermal 2-Seal Wing Nut Anchor (steel stud backup).
   4. Self-Adhesive Sheet Membrane for use under veneer anchors installed on sheathing and stud back-up:
      a. Self-adhesive butyl sheet membrane specified in weather-resistant barrier Section in Division 07.

2.06 FLASHINGS

A. Receivers and Counterflashing: Specified in Section 07 62 00 - Sheet Metal Flashing and Trim.

B. Other Flashing: Flexible, self-adhesive sheet membrane, as specified in Section 07 65 00 - Flexible Flashing.

2.07 ACCESSORIES

A. Expansion Joint Filler: Soft, closed cell neoprene rubber. Thickness 3/8 inch (10 mm) vertical joints, 1/4 inch (6 mm) horizontal joints. Depth equal to wythe less 3/8 inch (10 mm).
   1. Blok-Lok.
   2. Heckmann.
   3. H & B #NS Closed-Cell Neoprene Sponge.

B. Weeps and Vents: UV resistant polypropylene.
   1. Blok-Lok.
   2. Heckmann #85 Cell Vent.
   3. H & B #QV Quadro-Vent.

2.08 MIXING

A. Mortar for Clay or Shale Unit Masonry: ASTM C270, proportion specification; Type N.

B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio or that permitted by TMS 402/602.

C. Mixing Setting Mortar:
   1. Use a paddle type mechanical batch mixer.
   2. Use a positive means of measuring volumes of ingredients. Each batch shall contain a known volume of each ingredient. Measuring by shovels is not acceptable.
   3. Mix batches using whole sacks of cementitious materials unless another method of equivalent accuracy is approved by the Architect.
   4. Do not mix partial batches. Discard unused mix.
   5. Use mortar as soon as possible.
   6. Mortar that loses water by evaporation shall be retempered by the addition of water to restore its original consistency, providing the mortar has not begun to set.
   7. Do not re-temper colored mortar to the degree that variations in color are apparent in the completed masonry.
   8. Discard mortar that has begun to set.
   9. Discard mortar that has not been used after 2-1/2 hours after original mixing.

D. Mixing order when lime and cement are bagged together (confirm with manufacturer and notify Architect if manufacturer’s instructions differ):
   1. Water: 75% of total.
   2. Sand: Half.
   3. Lime and cement: All.
   4. Sand: The remainder.
   5. Water: To a workable consistency.
   6. Mix: Not less than 3-1/2 nor more than 5 minutes after the introduction of cementitious material.

E. Mixing order when lime and cement are bagged in two separate bags:
   1. Water: 75% of total.
   2. Sand: Half.
   3. Lime: All.
   4. Mix: 2 minutes.
   5. Portland Cement: All.
   6. Sand: The remainder.
   7. Water: To a workable consistency.

8. Mix: 5 full minutes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify that reinforcing dowels are properly positioned.
   2. Verify that items to be built-in such as pipes, conduit, boxes, and other items are properly positioned and do not interfere with masonry or reinforcing.
   3. Verify that non-masonry structural elements such as foundations for masonry, columns, beams, floor slab edges are properly positioned and do not interfere with masonry or required cavity.
   4. Verity that field measurements of project conditions allow for proper coursing both vertically and horizontally, unless otherwise required by the contract documents. Notify the Architect of non-coursing conditions.

B. Ensure that as-built field tolerances of other trades will permit the proper construction of masonry.

C. Bearing and Cavity Width:
   1. Do not allow clear air space behind veneer to be less than 1-1/2 inches (40 mm).
   2. Do not allow clay or shale brick to bear on less than 2/3 of their actual width.

D. Ensure that materials to be covered by masonry (such as steel studs, sheathing, insulation, membrane flashings, dampproofing, etc.) are complete and have been inspected and approved before covering with masonry.

E. As masonry construction progresses and before covering flashings with masonry, verify that flashings are properly located, sealed watertight, and constructed so as to direct water to the outside.

F. Where conditions are not compliant, notify the Architect before beginning masonry construction.

G. Provide corrected conditions before beginning masonry construction.

3.02 PREPARATION

A. Temporarily brace masonry until permanent bracing is provided.

B. Brace masonry in accordance with “Standard Practice for Bracing Masonry Walls Under Construction,” Council for Masonry Bracing.

3.03 PLACING UNITS

A. Solid units:
   1. Ensure bed and head joints are full of mortar without voids.
   2. Bevel bed joints with an appropriate quantity of mortar to fully fill the bed joint without overfilling, and without forcing excess mortar into the cavity or onto the face of units.
   3. Do not furrow bed joints.
   4. Place mortar on the head of the unit prior to placing, and shove into place.
   5. Do not slush head joints.

B. Ensure that units are in final position and adjusted to line, level, and plane before 60 seconds have expired since mortar contact with unit. Do not disturb units after this time. If further adjustment is required, remove unit and mortar and install fresh unit and mortar. Removed units may be reused if cleaned promptly and allowed to dry 24 hours before reuse.

C. Strike-off extruded mortar from the face and rear of the unit using a lifting and cutting motion of the trowel. Avoid dropping mortar in the cavity. Do not smear of mortar on the face of units.

3.04 COURSING AND JOINTING

A. Place units in running bond, unless otherwise indicated.

B. Do not tooth masonry. Rack masonry 1 unit per course where masonry is not laid continuously.

C. Joint thickness: 3/8 inches (10 mm). Construct joints of uniform thickness.
   1. Exception: Bed joint at foundations: Not less than 1/4 inches (6 mm) nor more than 3/4 inches (20 mm).
   2. Exception: Where stretching or compressing joints is necessary to accommodate dimensional tolerances or other conditions, consult with the Architect to determine acceptable tolerances.

D. Expansion Joints in Clay or Shale Masonry:
   1. Ensure that expansion joints are free of mortar and other obstructions.
   2. Place compressible expansion joint filler at proper depth to receive joint sealant.

E. Joint Shape:
   1. Concave, unless otherwise indicated.

F. Openings: Construct masonry openings for windows, doors, and penetrations to allow for proper sealant joint width between masonry and other material.
   1. Joint width adjacent to openings: 3/8 inch (10 mm) unless otherwise indicated on the drawings.

G. Where walls and partitions abut columns or other construction:

H. Where differing exterior masonry materials meet (brick, CMU, cast stone, precast concrete, cast-in-place concrete, etc.), rake back mortar to receive joint sealant specified in Division 07.

3.05 VENEER

A. Before constructing veneer, verify that spacing of veneer anchors in back-up is as specified.

B. Where built-in items such as pipes, conduit, boxes, and other items occur, ensure that such items do not interfere with proper cavity drainage. If such occur, consult with the Architect and provide custom flashing or other measures as approved.

3.06 CLEANOUTS AND WEEPS

A. Clay or Shale Masonry: Provide cleanouts at each flashing elevation, spaced 24 inches (610 mm) on center. Clean out accumulated mortar droppings from the cavity before mortar hardens throughout each work day and at the end of each work day. Achieve a mortar-free cavity.

B. Obtain the Architect's approval before permanently closing cleanouts.

C. Install weep devices at 24 inches (610 mm) on center.

D. Ensure that plastic weep device is seated on flashing - not held above flashing by mortar.

E. Three courses below flashings, install vent devices at 24 inches (610 mm) on center, offset 12 inches (300 mm) horizontally from weeps above.

3.07 VENEER ANCHORS

A. Where exterior cladding anchors (masonry veneer, metal cladding, and other penetrating materials) are mechanically fastened through the weather membrane, provide self-adhesive flashing underneath of anchors.
   1. Where the location of anchors is known in advance, individual pieces of butyl flashing (straight type) may be positioned to extend approximately 1/2 inch (13 mm) beyond the edges of the anchor.
   2. Where the location of anchors is not known in advance, or where anchors will be fastened blind through intervening layers of material such as continuous insulation, drain mats, furring, or other materials, place a continuous strip of butyl flashing (straight type) the full length of each stud or other framing member that will receive cladding anchors.
   3. Firmly press butyl flashing to ensure full adhesion.
   4. Ensure that anchors, securely fastened, form a tight compression seal against sheet material and weather membrane to create an air-tight and weather-tight seal.

B. Space anchors in compliance with all of the following:
   1. Not more than 2.67 sf (0.25 sq.m) of wall area per anchor.
   2. Not more than 18 inches (460 mm) vertically.

3. Not more than 32 inches (810 mm) horizontally.
4. Openings larger than 16 inches (400 mm) in either direction: Install additional anchors within 12 inches (300 mm) of opening, spaced at not more than 36 inches (910 mm) on center.
5. Locate the first row of anchors not more than 16 inches (400 mm) above bearing elevation.
6. Locate the last row of anchors not more than 8 inches (200 mm) below the top of masonry panel (top of parapet, top of wall, underside of structure, below shelf angle, etc.).
7. Where veneer corners are not masonry bonded (an expansion joint occurs at the corner), locate the first column of anchors within 12 inches (300 mm) of outside face of masonry in both directions.
8. Where veneer corners are masonry bonded (no expansion joint at the corner), locate the first column of anchors within 16 inches (400 mm) of the outside face of masonry in both directions.

C. Install adjustable anchors to allow for expansion of clay or shale masonry and contraction of back-up.

3.08 MASONRY FLASHING

A. Specified in Section 07 65 00 - Flexible Flashing.

3.09 OTHER MATERIALS

A. Build-in items specified elsewhere including, but not limited to:
1. Lintels.
2. Door frames. Fill hollow metal frames with grout.
3. Window frames.
4. Frames for openings.
5. Anchors for built-in items.
6. Inserts and connectors.
7. Utility items.

B. Simultaneously construct chases and contiguous walls or partitions.

C. Do not embed wood (whether or not preservative treated) or other organic materials.

D. Do not embed aluminum that has not been coated with an approved anti-corrosion coating.

3.10 CAST STONE INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cast stone components in conjunction with masonry.

C. Mechanically anchor cast stone units indicated; set remainder in mortar.

D. Setting:
1. Drench cast stone components with clear, running water immediately before installation.
2. Set units in a full bed of mortar unless otherwise indicated.
3. Fill vertical joints with mortar.
4. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.

3.11 TOLERANCES

A. Conform to both code and visual tolerances.

B. Code Tolerances: As specified in TMS 402/602.

C. Appearance of Completed Work: Variations in dimension, joint thickness, plumb, plane, line, alignment, offset, location in plan or elevation, etc., that are visible to the Architect under the criteria below shall be considered defective and shall, if ordered by the Architect, be corrected even though such conditions may fall within the tolerances specified in TMS 402/602.
1. The Architect will view the completed masonry to approve or reject the color consistency of the mortar, cleanliness of the masonry, and other aesthetic aspects of the work.
2. If the Contractor so requests, an initial determination will be made at not earlier than 2 weeks of age.

3. The Architect is the sole judge of aesthetic effect.
4. Initial approval will be given as a part of periodic site visits.
5. Final approval will be given only after scaffolding is removed and not earlier than 4 weeks after masonry has been laid.
6. Criteria for acceptance: Masonry shall be free of objectionable variations in color of the mortar, cleanliness of the new masonry, or other defective aesthetic effects. Lippage, or cocked or tilted masonry units are not acceptable.
7. Conditions for approval of completed appearance: Work will be viewed under normal daylight from a distance of 20 feet (6 m) (or more at the Architect's discretion), except in those areas where work occurs adjacent to entrances and walking surfaces, which will be viewed at close hand.
8. Variations from Code tolerances and defects that affect serviceability are not limited by viewing distance.

3.12 IN PROGRESS CLEANING

A. Arrange means, methods, and techniques of construction masonry and the work of other trades to avoid and prevent the soiling or staining of in-progress and completed masonry.

B. On-site Storage:
1. Protect masonry units from soil and mud.
2. Store units on pallets or equivalent to raise units above ground or place on well drained hard pavement. Do not place units directly on the ground.
3. Cover units with tarps to keep out precipitation. Ventilate tarps at the base to allow air circulation and to avoid condensation.

C. Protection:
1. Protect the base of masonry after the first course is laid. Use sand, straw, sawdust, plastic sheeting, etc., to prevent stains from mud and soil. Ensure proper drainage at base of wall to avoid retaining water and muddy conditions.
2. Cover the top of masonry with waterproof coverings at the end of each work day. Covers shall drape vertically at least 6 inches (150 mm) down inside and outside face of masonry. Secure covers against blowing wind.
3. Set scaffold far enough from the wall to allow mortar droppings to fall to the ground without staining completed masonry. At the end of each work day remove or tilt up scaffold board nearest the wall to dump mortar droppings and to prevent rainfall from splattering mortar from the board to newly constructed masonry.

D. Laying Masonry:
1. After spreading bed joint mortar and before placing brick, cut mortar from the wall face with the edge of a trowel to prevent mortar running down the wall.
2. After units are laid, cut off excess mortar, capturing it with the trowel so as not to allow excess to drop down the face of the wall.

E. After Completion:
1. Do not allow other trades to stain or soil completed masonry. Provide protection to avoid staining or soiling.
2. Keep mud protection at the base of masonry until permanent landscaping is completed and viable, effective groundcover is well established.

F. Tooling:
1. Tool joints when they are thumbprint hard.
2. Tool joints at about the same "age" from lift to lift of masonry, from section to section of masonry, from day to day, and from crew to crew.
3. Tool joints with a consistent technique.
4. Then cut off mortar tailings with a trowel and, using a medium soft hair bricklayer’s brush, brush mortar burrs and dust from the face of units.
5. At the start of work each morning, remove any remaining excess mortar from the face of units with a wire brush.

G. Non-Compliance with any of the above provisions is defective workmanship and grounds for rejection.

3.13 FINAL CLEANING

A. Specified in Section 04 01 20 - Masonry Cleaning.

END OF SECTION

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Structural steel.
   2. Shrinkage-resistant grout.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data:
   1. Structural-steel materials.
   2. High-strength, bolt-nut-washer assemblies.
   3. Anchor rods.
   4. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment Drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
   5. Identify members not to be shop primed.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer and fabricator.

B. Welding certificates.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU (Certified Building Fabricator).

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
   1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M.

FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:
   1. ANSI/AISC 303.
   2. ANSI/AISC 360.
   3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:
   1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles: ASTM A36/A36M.

C. Plate and Bar: ASTM A36/A36M.

D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

E. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

2.4 ANCHOR RODS

A. Headed Anchor Rods: ASTM F1554, Grade 36.
   1. Nuts: ASTM A563 heavy-hex carbon steel.
   2. Plate Washers: ASTM A36/A36M carbon steel.
   3. Washers: ASTM F436, Type 1, hardened carbon steel.
   4. Finish: Plain.

B. Threaded Rods: ASTM A193, Grade B7.
   1. Nuts: ASTM A63 heavy-hex carbon steel.
   2. Washers: ASTM F436, Type 1, Hardened.
   3. Finish: Plain.

2.5 PRIMER

A. Steel Primer:

1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer:
1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: ASTM A780/A780M.

2.6 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize loose lintels located in exterior walls.

2.10 SHOP PRIMING

A. Shop prime steel surfaces, except the following:
1. Galvanized surfaces.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.
1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates and Bearing Plates: Clean masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:
   1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
      a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.6 SPECIAL INSPECTIONS

A. Special Inspections will be performed by the Owner’s Special Inspector.

B. Verification and inspection of structural steel construction shall be in accordance with the 2018 North Carolina State Building Code and as follows:

C. Inspections:
   1. Periodically inspect erected steel framing to verify member locations, spacing, bearing conditions and connection details.
   2. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
   3. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
      a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at Special Inspector’s option:
         1) Liquid Penetrant Inspection: ASTM E165/E165M.
         2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
         3) Ultrasonic Inspection: ASTM E164.
         4) Radiographic Inspection: ASTM E94/E94M.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. All framing designated as “CFMF” on structural drawings.
   2. All framing designated as “CFSF-S” on architectural drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

1.4 QUALITY ASSURANCE

A. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   1. Grade: 50.
   2. Coating: G60.

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   1. Grade: 50.
   2. Coating: G90.

2.2 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Stud kickers, knee braces, and girts.
   8. Hole reinforcing plates.
   9. Backer plates.

2.3 ANCHORS, CLIPS, AND FASTENERS

A. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.4 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

2.5 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by screw fastening. Wire tying of framing members is not permitted.
      a. Locate mechanical fasteners and install according to Contract Drawings, with screw penetrating joined members by not less than three exposed screw threads.
   4. Fasten other materials to cold-formed metal framing by screw fastening, according to Contract Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed metal framing members by screw fastening. Wire tying of framing members is not permitted.

a. Locate mechanical fasteners and install according to Contract Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 INTERIOR LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:
1. Stud Spacing: 16 inches, maximum.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Install horizontal bridging in wall studs, spaced in rows indicated on Contract Drawings but not more than 48 inches apart. Fasten at each stud intersection.
1. Bridging: Cold-rolled steel channel, mechanically fastened to webs of punched studs.
2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

E. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.4 INTERIOR FLOOR JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Contract Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Contract Drawings.

C. Space joists not more than 2 inches from abutting walls, and as follows:
1. Joist Spacing: 16 inches, maximum.

D. Install bridging at intervals indicated on Contract Drawings. Fasten bridging at each joist intersection as follows:
1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.

E. Secure joists to load-bearing walls or supporting framing to prevent lateral movement of bottom flange.

F. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 SPECIAL INSPECTIONS

A. Special Inspections will be performed by the Owner’s Special Inspector.

B. Verification and inspection of cold-formed metal framing shall be in accordance with the 2018 North Carolina State Building Code and as follows:

C. Inspections:
1. Periodically inspect installed cold-formed metal framing to verify member sizes, gages, spacing and connection details.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05 51 00 - METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stairs with grating treads.

B. Prefabricated stairs.

C. Handrails and guards.

1.02 REFERENCE STANDARDS

A. AISC 201 - AISC Certification Program for Structural Steel Fabricators, Standard for Steel Building Structures; 2006.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2021a.

F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.

G. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

H. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021.

I. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).

J. NAAMM AMP 510 - Metal Stairs Manual; 1992.

K. NAAMM MBG 531 - Metal Bar Grating Manual; 2017.

L. NAAMM MBG 532 - Heavy Duty Metal Bar Grating Manual; 2019.

1.03 SUBMITTALS

A. Product Data: Provide for bar grating treads.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Design Data: As required by authorities having jurisdiction.

D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.

E. Designer's qualification statement.

F. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is certified under AISC 201.

1.04 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.

C. Fabricator Qualifications:

1. A company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to site structure.
   1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
   2. Structural Design: Provide complete stair and railing assemblies that comply with the following:
      a. Stair Capacity: Uniform live load of 100 lb/sq ft (4.7 kPa) and a concentrated load of 300 lb (14.4 kg) with deflection of stringer or landing framing not to exceed 1/360 of span.
      b. Railing Assemblies: Comply with applicable local code.
   3. Dimensions: As indicated on drawings.
   4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
   5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   6. Separate dissimilar metals using paint or permanent tape.

B. Metal Jointing and Finish Quality Levels:
   1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
      a. Welded Joints: Continuously welded and ground smooth and flush.
      b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
      c. Exposed Edges and Corners: Eased to small uniform radius.
      d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.

C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH GRATING TREADS

A. Jointing and Finish Quality Level: Architectural, as defined above.

B. Risers: Open.

C. Treads: Steel bar grating.
   1. Grating Type: Welded.
   2. Bearing Bar Depth: 3/4 inch (19 mm), minimum.
   3. Top Surface: Standard.
   4. Nosing: Checkered plate.
   5. Nosing Width: 1-1/4 inch (32 mm), minimum.
   6. Anchorage to Stringers: End plates welded to grating, bolted to stringers.

D. Stringers: Rolled steel channels.
   1. Stringer Depth: 10 inches (250 mm).
   2. End Closure: Sheet steel, 14 gauge, 0.075 inch (1.9 mm) minimum; welded across ends.

E. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.

F. Railings: Steel pipe railings.

G. Finish: Shop- or factory-prime painted.

2.03 HANDRAILS AND GUARDS

A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
   1. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.

B. Guards:
   1. Top Rails: Round pipe or tube rails unless otherwise indicated.
      a. Outside Diameter: 1-1/4 inch (32 mm), minimum, to 1-1/2 inches (38 mm), maximum.
   2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
      a. Outside Diameter: 1 inch (25 mm).
      b. Material: Steel pipe or tube, round.
      c. Vertical Spacing: Maximum 4 inches (100 mm) on center.
      d. Jointing: Welded and ground smooth and flush.
   3. End and Intermediate Posts: Same material and size as top rails.
      a. Horizontal Spacing: As indicated on drawings.
      b. Mounting: Welded to top surface of stringer.

2.04 MATERIALS

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.

C. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.

D. Gratings: Bar gratings that comply with NAAMM MBG 531 or NAAMM MBG 532, whichever applies based on bar sizes.

2.05 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Galvanizing: Hot-dip galvanize to minimum requirements of ASTM A123/A123M.
   1. Touch up abraded areas after fabrication using specified touch-up primer for galvanized surfaces.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.

D. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.

E. Obtain approval prior to site cutting or creating adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.02 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

END OF SECTION

SECTION 05 51 33 - METAL LADDERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prefabricated ladders.

1.02 REFERENCE STANDARDS

A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).

1.03 SUBMITTALS

A. Shop Drawings:

1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.

B. Mechanical Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

C. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

2.02 PREFABRICATED LADDERS

A. Prefabricated Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.

1. Components: Manufacturer's standard rails, rungs, treads, handrails. returns, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
2. Materials: Carbon steel; ASTM A1011/A1011M, Grade 36, minimum.
3. Finish: Powder coat; color to be selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION

SECTION 05 53 13 - BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal bar gratings.

B. Related Requirements:
   1. Section 051200 "Structural Steel Framing" for structural-steel framing system components.

1.2 SUBMITTALS

A. Product Data:
   1. Clips and anchorage devices for gratings.
   2. Paint products.

B. Shop Drawings:
   1. Include plans, sections, and attachment details.
   2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.

1.3 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Ohio Gratings, Inc

B. McNichols Co

C. McMaster Carr

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Uniform load of 100 lbf/sq. ft.

2.3 METAL BAR GRATINGS

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531.

B. Welded Steel Grating:
   1. Grating Mark W-11-2 (2 x 1/4) STEEL: 2-by-1/4-inch bearing bars at 11/16 inches o.c., and crossbars at 2 inches o.c.
   2. Grating Mark: As indicated.
   3. Traffic Surface: Serrated.
   4. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless steel fasteners for fastening stainless steel.

2.5 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.6 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

D. Galvanized-Steel Sheet: ASTM A653/A653M, structural quality, Grade 33, with G90 coating.

2.7 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
   1. Provide no fewer than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
   2. Provide no fewer than four saddle clips for each grating section containing rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
   3. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
   1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

I. Do not notch bearing bars at supports to maintain elevation.

2.8 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

3.2 INSTALLATION OF METAL BAR GRATINGS

A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 REPAIR

A. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

SECTION 05 70 00 - DECORATIVE METAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Railing and guardrail assemblies.

B. Wall-mounted handrails.

1.02 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

D. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.

E. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

F. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product data, including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.

B. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.

C. Samples: Submit one (1) of each item below for each type and condition shown.
   1. Railing: 12 inch (305 mm) long section of handrail illustrating color, finish and connection detail.

D. Test Reports: Submit test reports from an independent testing agency showing compliance with specified design and performance requirements.

E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in factory-provided protective coverings and packaging.

B. Protect materials against damage during transit, delivery, storage, and installation at site.

C. Inspect materials upon delivery for damage. Repair damage to be indistinguishable from undamaged areas; if damage cannot be repaired to be indistinguishable from undamaged parts and finishes, replace damaged items.

D. Prior to installation, store materials and components under cover in a dry location.

1.05 FIELD CONDITIONS

A. Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F (18.3 degrees C) and maximum 95 degrees F (35 degrees C).

B. Maintain ambient temperature of space at minimum 65 degrees F (18.3 degrees C) and maximum 95 degrees F (35 degrees C) for 24 hours before, during, and after railing installation.

1.06 WARRANTY

A. Warranty: Manufacturer's standard one year warranty against defects in materials, fabrication, finishes, and installation commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 RAILING SYSTEMS

A. Railing Systems - General: Factory- or shop-fabricated in design indicated, to suit specific project conditions, and for proper connection to building structure, and in largest practical sizes for delivery to site.
   1. Performance Requirements: Design and fabricate railings and anchorages to resist the following loads without failure, damage, or permanent set; loads do not need to be applied simultaneously.
      a. Lateral Force: 75 lb (333 N) minimum, at any point, when tested in accordance with ASTM E935.
      b. Distributed Load: 50 lb/ft (0.73 kN per m) minimum, applied in any direction at the top of the handrail, when tested in accordance with ASTM E935.
      c. Concentrated Loads on Intermediate Rails: 50 psf (0.22 kgs per sq m), minimum.
      d. Concentrated Load: 200 lbs (888 N) minimum, applied in any direction at any point along the handrail system, when tested in accordance with ASTM E935.
   2. Assembly: Join lengths, seal open ends, and conceal exposed mounting bolts and nuts using slip-on non-weld mechanical fittings, flanges, escutcheons, and wall brackets.
   3. Joints: Tightly fitted and secured, machined smooth with hairline seams.
   4. Field Connections: Provide sleeves to accommodate site assembly and installation.

B. Wall-Mounted Handrail (05 70 00.HRW):
   1. 2-1/2 inch (64 mm) diameter, wood.
   2. Handrail Brackets (05 70 00.B): Manufacturer's standard aluminum brackets.
      a. Mounting: Wall.
      b. Finish: Clear anodized.

2.02 MATERIALS

A. Aluminum Components: ASTM B221 or ASTM B221M.
   1. Clear Anodized Finish: Class I, AAMA 611 AA-M12C22A41 Clear anodic coating with electrolytically deposited organic seal; not less than 0.7 mils (0.018 mm) thick.

B. Wood for Railings: Comply with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 7 - Stairwork & Rails, at manufacturer's standard grade.
   1. Species: White oak.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's drawings and written instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.

C. Anchor securely to structure.

D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

E. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

END OF SECTION

SECTION 06 10 00 - ROUGH CARPENTRY

06 10 00.TFR Fire Retardant Treated

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire retardant treatment of wood.

1.02 REFERENCES

A. AWPA U1 - Use Category System: User Specification for Treated Wood; 2022.

1.03 SUBMITTALS

A. Product Data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect wood products against moisture and dimensional changes. Support stacks at several uniformly spaced points to prevent deformation. Store stacks raised above ground. Cover to protect from rain and snow. Select and arrange cover to allow air circulation under and all around stacks to prevent condensation. Maintain and restore displaced coverings. Remove from the site any wood products that have been subjected to moisture or that do not comply with the specified moisture requirements.

PART 2 PRODUCTS

2.01 WOOD PRODUCTS

A. Acceptable Lumber Inspection Agencies: Any agency with rules approved by American Lumber Standards Committee.

B. Grade Stamps for Concealed Lumber: Each piece of lumber, applied by inspection agency and showing compliance with each specified requirement.

C. Marking of Treated Wood: Each piece of lumber or plywood, applied by inspection agency, and showing compliance with specified standards.

2.02 WOOD TREATMENT

A. Treat all lumber and all construction panels used in building construction unless untreated material is explicitly specified by the use of the words "fire retardant or preservative treatment is not required" or similar language.
   1. Except where required to be untreated, all lumber and all construction panels used in building construction shall be fire retardant treated, except pressure preservative treated lumber and construction panels not required to be fire retardant treated.
   2. Furniture, furnishings, finish carpentry, and architectural woodwork are not specified in this Section and are subject to treatment requirements, if any, specified in their respective Specification Sections.

B. Fire Retardant Treatment: Treat wood used in the locations described below. Kiln dry after treatment to 19 percent maximum moisture content for lumber and 18 percent for plywood. Provide wood treated according to AWPA U1 with Use Category (UC) suitable for actual service encountered on the Project. Provide product with factory-applied colored dye to readily identify the material on site.
   1. Fire Retardant Interior (UCFA): Low hygroscopic, and meeting AWPA U1 Commodity Specifications A (lumber) and F (plywood) for preservative qualities in above-ground, weather-protected locations.
      a. Lonza Wood Protection; “Dricon Fire Retardant Treated (FRT)" wood.
   2. Interior uses.

2.03 FASTENERS

A. Material:

1. Interior Untreated Wood: Steel.

B. Provide fasteners as required by applicable codes and as specified in this Section unless other types and spacings are indicated for specific uses.

PART 3 EXECUTION

3.01 INSTALLATION

A. Arrange work to use full length pieces except where lengths would exceed commercially available lengths. Discard pieces with defects that would lower the required strength or appearance of the work.

B. Cut and fit members accurately. Install plumb and true to line and level.

C. Fasten carpentry in accordance with applicable codes and recognized standards.

D. Where exposed, countersink nails and fill flush with suitable wood filler.

E. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

END OF SECTION

SECTION 06 20 00 - FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Finish carpentry items.

B. Wood casings and moldings.

1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2020.

1.03 SUBMITTALS

A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.
   2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

B. Samples: Submit two samples of wood trim 6 inch (152.4 mm) long.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect from moisture damage.

B. Handle materials and products to prevent damage to edges, ends, or surfaces.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

A. Interior Woodwork Items:
   1. Moldings, Bases, Casings, and Miscellaneous Trim: Plain-sawn poplar; prepare for paint finish.
      a. Finish: Paint.
      b. Chair Rail Profile (062000.CR1): 7/8" x 2 1/4 inch chair rail.
         1) Profile: Based on Moldings One profile 4086; https://www.mouldingsone.com/
      c. Chair Rail Profile (062000.CR2):
         1) Profile: Match Existing
      d. Wall Base (062000.WB1): 8 inch wall base.
         1) Profile: Based on Moldings One profile 2151; https://www.mouldingsone.com/

2.02 FASTENINGS

A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.

B. Fasteners: Of size and type to suit application; seal finish in concealed locations and stain and seal finish in exposed locations.

C. Concealed Joint Fasteners: Threaded steel.

2.03 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Lumber for Shimming and Blocking: Softwood lumber of Poplar species.

C. Wood Filler: Solvent base, tinted to match surface finish color.

2.04 FABRICATION

A. Shop assemble work for delivery to site, permitting passage through building openings.

B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

A. Set and secure materials and components in place, plumb and level.

B. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim to conceal larger gaps.

END OF SECTION

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK & UPHOLSTERED BENCH SEATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plastic Laminate Cabinets.

B. Plastic Laminate Wall Panels.

C. Upholstered Bench Seating.

D. Cabinet Hardware.

1.02 REFERENCES

A. ANSI A135.4 - Basic Hardboard; 2012 (Reaffirmed 2020).

B. ANSI A208.1 - American National Standard for Particleboard; 2022.

C. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.

D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

E. BHMA A156.9 - Cabinet Hardware; 2020.

F. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.03 SUBMITTALS

A. Product Data.

B. Samples: Submit two samples of each finish material.

C. Upholstered Bench Samples: Submit two samples of upholstery from dye lot. Mark top and face of fabric.

D. Shop Drawings: Include plans, elevations, sections, details, materials, assembly methods, joint details, fastening methods, accessory listings, hardware location and schedule of finishes.

1.04 QUALITY ASSURANCE

A. Standards: Verify selections made under Sample submittals, demonstrate aesthetic effects, and set quality standards for fabrication and installation.
   1. Except as otherwise shown or specified, comply with specified provisions of the American Woodwork Institute (AWI) "Quality Standards".
   2. Source Limitations: Obtain fixed seating from single source from single manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.06 COORDINATION:

A. Upholstered Bench: Contractor to purchase all materials (inlcuding fabrics) to complete bench in full. Contractor to provide all filler trim and scribe trim peices as required.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Protect units from moisture damage.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fixed seating that fail in materials or workmanship within 5 year warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures.
      b. Wear and deterioration of fabric and stitching beyond normal use.
   2. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

a. Plastic, Wood, and Paint Components: Five years.

1.09 PROJECT CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

1.10 CLOSEOUT SUBMITTALS

A. Include the following:
1. Methods for maintaining upholstery fabric.
2. Precautions for cleaning materials and methods that could be detrimental to seating finishes and performance.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Source Limitations:
1. Upholstery Fabric: Obtain fabric of a single dye lot for each color and pattern of fabric required.

2.02 PERFORMANCE REQUIREMENTS FOR SEATING

A. Fire-Test-Response Characteristics of Upholstered Chairs:
1. Fabric: Class 1 according to DOC CS 191-1953 or 16 CFR 1610, tested according to California Technical Bulletin 117.
2. Padding: Comply with California Technical Bulletin 133.

B. Strength and Durability Performance: Chairs and components shall pass testing according to BIFMA X5.4.

C. Finished product must be Class B or better per ASTM E84 or UL723.

2.03 CABINET CONSTRUCTION

A. Perform cabinet construction in accordance with AWI/AWMAC/WI (AWS) Section 400 as follows:
1. Plastic Laminate Cabinets: Custom quality.

2.04 PANEL MATERIALS

A. Particleboard: ANSI A208.1; medium density industrial type, composed of wood chips bonded with interior grade adhesive under heat and pressure; sanded faces; thickness as required; use for components indicated on drawings.

B. Medium Density Fiberboard (MDF): ANSI A208.2; composed of wood fibers pressure bonded with moisture resistant adhesive to suit application; sanded faces; thickness as required.

C. Hardboard: ANSI A135.4; Pressed wood fiber with resin binder, Class 1 - Tempered, 1/4 inch (6 mm) thick, smooth two sides (S2S). Use for drawer bottoms, dust panels, and other components indicated on drawings.

2.05 LAMINATE MATERIALS

A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications and as follows:
1. Exposed Surfaces: HGS, 0.048 inch (1.2 mm) inch nominal thickness, through color, colors as scheduled, finish as scheduled.
2. Cabinet Liner: CLS, 0.02 inch (0.5 mm) nominal thickness, through color, colors as scheduled, finish as scheduled.
3. Laminate Backer: BKL, 0.02 inch (0.5 mm) nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

B. Manufacturers:
1. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within

the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

2. Plastic Laminate 1, 064100.PL1; BASIS OF DESIGN: WilsonArt International: www.wilsonart.com.
   a. Premium Grade, River Cherry 7937-58
   b. Representative Contact: April Brickle, brickla@wilsonart.com, 540.537.343
3. Other acceptable manufacturers:
   a. Formica Corporation: www.formica.com.
      1) Premium Grade, Oiled Legno 8846-58.
      2) Representative Contact: Sheri Reid, sheri.reid@formica.com, 704.534.7300
   b. Panolam Industries: www.pionitelaminates.com.
      1) Premium Grade, Kingsley WW011 Suede.
      2) Representative Contact: Betty Gerula, betty_gerula@panolam.com,

2.06 UPHOSLTERED BENCH SEATING MATERIALS

A. Composite Wood Products: Made with binder containing no urea formaldehyde.
   1. Medium-Density Fiberboard: ANSI A208.2, Grade MD.
   2. Concealed Plywood: HPVA HP-1 hardwood plywood or DOC PS 1 softwood plywood as standard with manufacturer.
   3. Exposed Plywood: HPVA HP-1, Face Grade A, hardwood-veneer core with color matched hardwood-veneer faces.

2.07 ACCESSORIES

A. Fasteners: Size and type to suit application.

B. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel, or chrome-plated finish in exposed locations.

C. Concealed Joint Fasteners: Threaded steel.

2.08 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards and coordinated shelf rests, satin chrome finish, for nominal 1 inch (25 mm) spacing adjustments.

C. Drawer and Door Pulls: Basis of Design: Hafele Vogue pull 155.00.041, polished chrome, 5 inch (128 mm) centers.

D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with satin finish.

E. Catches: Magnetic.

F. Drawer Slides:
   1. Manufacturers:
      a. Basis of Design: Accuride International, Inc.
      b. Hafele America Co.
      c. Knape & Vogt Manufacturing Company.
   2. Light/Medium Duty Drawer Slides For Drawers 24 inches (609 mm) Wide or Less: Accuride 7434 with overtravel.
      a. Overtravel: 1 inch (25 mm).
      b. Type: All ball bearing, full extension, rail-mounted, hold-in detent, smooth progressive movement.
      c. Capacity: 100 pounds (45 kg) per pair for 18-inch (457 mm) slide length.
      d. Finish: Clear zinc.

G. Hinges: 5 knuckle type; stainless or chromium plated steel with satin polished finish.

2.09 FABRICATION - CABINETS

A. Cabinet Style: Flush overlay.

B. Cabinet Doors and Drawer Fronts: Flush style.

C. Drawer Construction Technique: Dovetail joints.

D. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

E. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

F. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

G. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet (0.6 m) from sink cut-outs.
   1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
   2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

2.10 FABRICATION - UPHOLSTERED BENCH

A. Structural Frame: Standard Grade lumber or plywood complying with the requirements of Section 06 1000. Use 0.75" thick softwood plywood for concealed plywood.

B. Comply with AWI Premium Grade on exposed hardwood, as applicable to construction techniques, materials and joinery.

C. Upholstery: Fabricate fabric-covered cushions with molded padding and batting beneath fabric, and with fabric covering free of welts, creases, stretch lines, and wrinkles. For each upholstered component, install pile and pattern run in a consistent direction.

D. Apply padding to plywood with not less than three Velcro strips running longitudinally continuously across length of pad to within 1" of each end.

E. Upholster with a single piece of fabric to the greatest extent possible. Conceal all terminations out of normal view. Reinforce seams.

F. Fabric Seat Construction:
   1. High Density Foam Backing; 3" thick minimum, over 9 gauge spring units (marshall units). Spring units are wrapped with 3 layers of cotton and final wrap with Dacon. Attach with hog rings. Refer to drawing section for dimensions. Reinforced seat frame featuring lap jointed stabilizer seat ends to discourage warp and cupping.
   2. Seat Style: Box cushion
      a. Provide matching welts at edges
   3. All but invisible blind stitching.

G. Fabric Back Construction:
   1. High Density Foam Backing; 1" thick minimum, over 9 gauge commercial grade sinuous springs 3 inches on center. on masonite backing on solid wood frame. refer to drawing section for angle slant of cushion.
   2. All but invisible blind stitching.
   3. Piping at all edge seams.

H. All joints to be mitered and eased.

I. Size: Refer to architectural drawings for dimensions and details.

J. Upholstered Bench Fabric:
   1. 06 4100.UPH1; Fabric Seat & Back Cushion:
      a. BASIS OF DESIGN Manufacturer: Momentum Textiles; www.https://momentumtextilesandwalls.com
      b. Series: Dexter EPU

c. Color: Tango
d. Repeat: 20" vertical x 9 1/2" height
e. Content: 100% EPU Polyurethane
f. Backing: Polyester
g. Railroad: No
h. Width: 54"
i. Durability: 285,000 Double Rubs.
j. Flame Resistance: CA Bulletin 117 2013 & ASTM D3690 Class A.
k. Maintenance: Water based foam or cleaner, Bleach Cleanable (4:1)
l. Other Acceptable Manufacturers:
1) Arc-Com, www.arc-com.com
2) Architex, www.architex.com
3) CF Stinson, www.cfstinson.com
4) DesignTex, www.designtex.com
5) Mayer Fabrics, www.mayerfabrics.com

K. Attachments:
1. Attach seat cushion to bench with industrial velcro.
2. Attach back panel and ceiling panels with Z clips.

L. Finish product must be Class B or better per ASTM E84 or UL723.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION - CABINETS

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

B. Use concealed joint fasteners to align and secure adjoining cabinet units.

C. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.8 mm). Do not use additional overlay trim for this purpose.

D. Secure cabinets to floor using appropriate angles and anchorages.

E. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 INSTALLATION - UPHOSLTERED BENCH

A. Install banquettes and bench in locations designated on drawings.
1. Install level, plumb, true as indicated on the shop drawings.
2. Protect units in transport.
3. Protect floor and corners when moving units.

3.04 ADJUSTING - CABINETS

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.05 ADJUSTING - UPHOLSTERED BENCH

A. Install banquettes and bench in locations designated on drawings.
1. Install level, plumb, true as indicated on the shop drawings.
2. Protect units in transport.
3. Protect floor and corners when moving units.
4. Replace upholstery fabric damaged during installation or work of other trades.

3.06 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

B. Clean and vaccum seating standards and fabrics.

LOGIC

END OF SECTION

SECTION 06 42 00 - WOOD PANELING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plastic laminate faced wood paneling.

B. Shop finishing.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Grounds and concealed blocking.

1.03 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2020.

D. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 SUBMITTALS

A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.
   2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

B. Samples:
   1. Submit two samples of refinished reclaimed wood plank flooring in a 12 inch length size illustrating final finish.

C. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.05 QUALITY ASSURANCE

A. Quality Certification:
   1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
   2. Provide designated labels on shop drawings as required by certification program.
   3. Provide designated labels on installed products as required by certification program.
   4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect work from moisture damage.

B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with applicable codes for fire-retardant requirements.

2.02 PANELING

A. Recycled/Reclaimed Wood Plank Office Flooring (064200.RWP1):
   1. Stripped and refinish to match architect's control sample.

B. Wood Paneling (064200.WP1):
   1. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.
   2. Flat Paneling:
      a. Species: cherry.
      b. Cut: figured.
      c. Panels: Veneer of full width and balanced sequence matched.
      d. Visible Edges and Reveals: Match faces.
      e. Outside Corners: Mitered and splined.

2.03 WOOD-BASED MATERIALS - GENERAL

A. Provide sustainably harvested wood, certified or labeled as specified in Section 01 60 00.

B. Hardwood Plywood: HPVA HP-1 Grade A; veneer core, type of glue recommended for application; of grain quality suitable for transparent finish.

C. Lumber: Maximum moisture content of 6 percent; with vertical grain, of quality suitable for transparent finish.

2.04 LAMINATE MATERIALS

A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications and as follows:
   1. Exposed Surfaces: HGS, 0.048 inch (1.2 mm) inch nominal thickness, through color, colors as scheduled, finish as scheduled.
   2. Cabinet Liner: CLS, 0.02 inch (0.5 mm) nominal thickness, through color, colors as scheduled, finish as scheduled.
   3. Laminate Backer: BKL, 0.02 inch (0.5 mm) nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

B. Manufacturers:
   1. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.
   2. Plastic Laminate 1, 064100.PL1; BASIS OF DESIGN: WilsonArt International: www.wilsonart.com.
      a. Premium Grade, River Cherry 7937-58
   3. Other acceptable manufacturers:
      a. Formica Corporation: www.formica.com.
         1) Premium Grade, Oiled Legno 8846-58.
      b. Panolam Industries: www.pionitelaminates.com.
         1) Premium Grade, Kingsley WW011 Suede.

2.05 ADHESIVES AND FASTENERS

A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.

B. Fasteners: Z-clips in size and type to suit applications.

2.06 SHOP TREATMENT OF WOOD MATERIALS

A. Shop pressure treat wood materials requiring UL fire rating to concealed wood blocking.

B. Provide UL approved identification on fire-retardant treated material.

2.07 FABRICATION

A. Prepare panels for delivery to site, permitting passage through building openings.

B. Finish exposed edges of panels as specified by grade requirements.

2.08 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
   1. Transparent:
      a. System - 1, Lacquer, Nitrocellulose.
      b. Stain: As selected by Architect.
      c. Sheen: Satin.

2.09 ACCESSORIES

A. Metal Trim:
   1. Corner Trims (064200.CT1):
      a. Material: Extruded aluminum.
      b. Shape: U channel.
      c. Manufacturer:
         1) BASIS OF DESIGN: Fry Reglet OC3 Integral Outside Corner FCP-INTOSCNR.
            (a) Material:
            (b) Size: 3/8" x 3/4"
            (c) Color: Woodtone Powder Coat Finish. Submit full line of sample chips for designer/architect to select from.
         2) Other acceptable manufacturers:
            (a) Eagle Mouldings, Inc; www.eagle-aluminum.com/#sle.
            (b) Gordon, Inc; www.gordon-inc.com.
   2. Reveals (064200.RT1):
      a. Material: Extruded aluminum.
      b. Shape: U channel.
      c. Height: 1/2 inch (12.7 mm).
      d. Color: Black
      e. Manufacturers:
         1) Eagle Mouldings, Inc; _____: www.eagle-aluminum.com/#sle.
         2) Fry Reglet: Millwork Reveal MWR5050; www.fryreglet.com.
         3) Gordon, Inc; www.gordon-inc.com.

B. Lumber for Shimming, Blocking: Softwood lumber of similar species.

C. Wood Filler: Tinted to match surface finish color.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Verify adequacy of backing and support framing.

C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Do not begin installation until wood materials have been fully acclimated to interior conditions.

C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.

D. Where necessary to cut and fit on site, scribe work abutting other components. Do not use additional overlay trim to conceal gaps.

E. Remove dirt and other foreign matter from reclaimed planks prior to assembling panels.

F. Refer to architectural drawings for wood pattern installation for both panels and reclaimed planks.

G. Mitre edge joints of reclaimed wood planks.

H. Seal all exposed/cut wood edges.

I. Once all reclaimed wood planks are installed provide a light grit sand panels without removing striping and seal uniformly with one coat of a ceramic-reinforced water-based 2-Component polyurethane finish.

3.03 PREPARATION FOR FIELD FINISHING

A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.

3.04 TOLERANCES

A. Maximum Variation from True Position: 1/16 inch (1.6 mm).

B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch (0.8 mm).

END OF SECTION

SECTION 07 10 00 - WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Products include:
   1. Cold, fluid applied membrane waterproofing.
   2. Drainage layer.
   3. Applicable sealants, waterstops, waterproofing flashings, and accessories needed to ensure a complete waterproof system.

B. Apply waterproofing to the following surfaces:
   1. Concrete walls that separate soil from interior space.
   2. Existing walls that separate soil from interior space.

1.02 REFERENCES

A. ASTM D6506 - Standard Specification for Asphalt Based Protection for Below-Grade Waterproofing; 2001 (Reapproved 2009).

1.03 SUBMITTALS

A. Product Data:
   1. Manufacturer's specifications and other data needed to demonstrate compliance with the specified requirements.
   2. Catalog illustrations or manufacturer's standard detail drawings in sufficient detail to show installation and interface of the work of this Section with the work of adjacent trades.
   3. For information (Project Record): Manufacturer's detailed installation instructions. No provision of such instructions shall be deemed to modify any requirement of the Contract Documents without the approval of the Architect, and issued as a Contract Modification.

B. Shop Drawings:
   1. If not covered by manufacturer's standard detail drawings, indicate project-specific joint and termination conditions and interface with other materials.

C. Certificates:
   1. Installer qualifications.

D. Schedule: Submit construction schedule indicating anticipated beginning and ending dates of the following tasks. Where work will be conducted independently in more than one area or zone, submit for each area or zone. No area or zone shall consist of less than 5000 sq ft (465 sq m) without the advance approval of the Architect.
   1. Preapplication review.
   2. Preconstruction inspection.
   3. Preparation work.
   4. Membrane installation.
   5. Drainage system.
   6. Final surface covering such as ballast, pavers, soils, or other materials.

E. Submit reports signed by Contractor, installer, and waterproofing manufacturer's representative of:
   1. Preapplication review.
   2. Preconstruction inspection.
   3. Membrane/substrate adhesive.
   4. Completion inspections.
   5. Report of inspection at final completion.

F. Warranty.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with at least 10 years documented experience and certified by the membrane manufacturer.
   1. Certification:
      a. Installer shall be a company licensed or certified by the waterproofing materials manufacturer for materials specified in this section and for projects similar in scope to work included.
      b. Certification or licensing shall have been in effect continuously for at least one year prior to the date of bid or, if none, the date of award of the general contract, for this Project.
      c. Certification or licensing shall qualify for manufacturer's premium labor and material warranty.
   2. Installer shall have at least three years experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity. Provide current phone contacts of Architects and Owners for verification.
   3. Installer shall designate a single individual as project foreman who shall be on site at all times during installation. Installer shall designate key personnel of the on-site crew who shall be experienced in work of the type specified. Neither the foreman nor the key personnel shall be changed without the Architect's consent.

1.05 PREINSTALLATION MEETINGS

A. Substrate Review: Before start of construction of surfaces to receive membrane and after approved submittals have been received by the Contractor, schedule a meeting with membrane installer including the foreman, installers of work adjacent to or which penetrates membrane, Architect, Owner's representative, and membrane manufacturer's representative.
   1. Review procedures for substrate construction and preparation.
   2. Review Contract Document requirements for membrane and membrane manufacturer's product data and application instructions.
   3. Review locations of conduits, piping, etc. Review requirements for horizontal and vertical clearances between adjacent penetrations and curbs, corners, walls, or footings.
   4. Review coordination of related work, preliminary installation schedule, inspection and testing methods, and certifications.
   5. Review Contract Document requirements and submittals for system, including installation schedule, inspection and testing, and environmental conditions.
   6. Identify any differences between contract requirements and manufacturer's recommendations or warranty requirements.
   7. Obtain the Architect's written approval of any deviations from contract requirements.
   8. Document discussion in writing, including issues requiring action, and distribute report to entities concerned with membrane installation, substrate construction, mechanical and electrical construction, and related work.

B. Membrane Preinstallation Review: Before start of work, schedule a meeting with membrane installer including the membrane installer's foreman, Architect, Owner's representative, and membrane manufacturer's representative.
   1. Review each issue identified in the Substrate Preconstruction Review meeting.
   2. Walk areas to review and discuss substrate preparation including repair.
      a. Unacceptable surfaces.
      b. Drainage, flatness, and slope.
      c. Penetrations.
      d. Curbs.
      e. Work performed by other trades which requires coordination with membrane system.
      f. Review fastening of insulation, flashings, drainage system, and other membrane components.
   3. Document discussion in writing, including issues requiring action, and distribute report to entities concerned with membrane work and related work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to job site in manufacturer's unopened containers with all labels intact and legible at time of use.

B. Store the products in a dry condition during delivery, storage, handling, installation, and concealment.

C. Protect materials from prolonged sunlight exposure.

1.07 PROJECT CONDITIONS

A. Complete the construction of substrates, including work which will penetrate membrane, before start of membrane installation.

B. Comply with manufacturer's recommendations regarding condition of the substrate to receive membrane, weather conditions before and during installation, and protection of the installed membrane system.

C. Do not install primer or other materials during wet weather.

D. Do not install primer or other materials when air or substrate temperatures are below 40 deg F (5.0 deg C).

E. Maintain substrate and ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application and until liquids, mastics, and adhesives have cured.

1.08 SEQUENCING AND SCHEDULING

A. Normal Weight Concrete: Install membrane not sooner than recommended by membrane manufacturer, but in no case sooner than 7 days after placement of concrete.

B. Schedule installation of liquid-applied membranes to occur when temperatures are within specified ranges.

C. Schedule subsequent construction and coverings to occur as soon as practicable after membrane installation, testing, and acceptance in order to avoid traffic on membrane and to protect membrane from sunlight and damage.

1.09 WARRANTY

A. Provide Special Project Warranty specified in Section 01 78 10 - Special Project Warranty on Roofs and Walls.

B. Provide membrane manufacturer's premium material and labor warranty covering the following:
   1. Correct defective work within a five year period after Date of Final Completion.
   2. Provide five year manufacturer warranty for membrane failing to resist penetration of water.
   3. Permissible exception: where penetration of water is the result of structural failure or defect. Hairline cracking of concrete is not considered a structural failure or defect for purposes of this warranty.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 COLD FLUID-APPLIED MEMBRANE WATERPROOFING

A. Manufacturers:
   1. Carlisle Coatings & Waterproofing (CCW); CCW-Miraseal reinforced liquid-applied waterproofing: carlisleccw.com
      a. Vertical surfaces" 120 mils (3 mm) wet, 120 mils (3 mm) dry.
   2. Henry Company; Elasto-Seal CM100 High Build reinforced membrane: www.Henry.com.
      a. Vertical surfaces: 110 mils (2.8 mm) wet, 107 mils (2.7 mm) dry.
   3. GCP Applied Technologies:

a. Vertical surfaces: Procor 3R Waterproofing System plus Composite Sheet fully adhered as a protection course / separation sheet; membrane thickness (excluding composite sheet) 120 mils (3 mm) wet and dry.
b. Procor 75 Spray Grade for horizontal and vertical applications
c. Procor 20 Trowel Grade for vertical applications and detailing.

B. Required Thickness:
1. Application mil thickness stated above does not include thickness of reinforcing or the thickness of the protection course / separation sheet, which are in addition to the thickness of the applied liquid thickness.

C. Primer: As recommended by membrane manufacturer.

D. Fabric Reinforcement:
1. CCW: CCW-500 Reinforcing Fabric in the field; Liquifiber at details.
2. Henry: Henry Polyester Fabric.
3. GCP: Procor Reinforcement Mesh

E. Neoprene Joint Membrane:
1. CCW: Material and style as recommended by membrane manufacturer.
2. Henry: Neoflash and neoflash adhesive.
3. GCP: As recommended by membrane manufacturer.

F. Penetration and Termination Sealant:
1. CCW: As recommended by membrane manufacturer.
2. Henry: HE925 BES Sealant.
3. GCP: Bituthene Liquid Membrane.

G. Protection Course / Separation Sheet:
1. CCW:
a. Vertical surfaces: CCW Protection Board-V.
2. Henry Company; ModifiedPlus G100s/s.
3. GCP: Procor Composite Sheet; fully adhered in liquid; applied butt-jointed with strips of Bituthene Low Temp at butt joints.

H. Drainage Layer:
1. CCW:
a. Vertical surfaces: CCW Miradrain, type and style suitable for project conditions.
2. Henry:
a. Vertical surfaces: Henry DB 220.
3. GCO:
a. Walls: Hydroduct 200 Drainage Composite.
4. Filter fabric roll stock: In addition to wide rolls of drainage layer for use as overlay, provide 36 inches (914 mm) -wide filter fabric roll stock for envelopes, edges, and detailing of other conditions.
5. Adhesive for insulation and drainage layer: As recommended by manufacturer. Do not penetrate membrane below grade.

2.03 ACCESSORIES

A. Temporary Protection Board: ASTM D6506, Type 3; semirigid sheets of fiberglass or mineral reinforced asphaltic core, pressure laminated between two asphalt saturated, fibrous liners.
1. Product:
a. W.R. Meadows, Inc.; Sealtight PC-3 Heavy Duty: www.wrmeadows.com.
2. Thickness: 1/4 inch (6 mm).

PART 3 EXECUTION

3.01 GENERAL

A. Execute surface preparation, detailing procedures, and installation procedures in accordance with this Specification, Drawings, and the manufacturer's instructions.

B. If manufacturer's installation instructions deviate from requirements of this section, obtain the Architect's written approval of deviations before proceeding.

C. Protect adjacent surfaces not designated to receive membrane.

D. Clean and prepare surfaces to receive membrane in accordance with manufacturer's instructions. Ensure that substrate is dry and free of dirt, dust, and debris.

E. Do not apply membrane to surfaces unacceptable to membrane manufacturer.

F. Provide drop cloths or masking as required to prevent spilling and soiling of adjacent surfaces not indicated to receive membrane.

G. Lay out project to determine and anticipate conditions prior to start of work.
   1. Note termination and penetration conditions to determine methods for creating a waterproof envelope. Verify that where below-grade waterproofing extends to grade, other waterproofing provides protection for substrate continuing above grade.

3.02 SURFACE CONDITIONS

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section and to prevent damage to installed membrane.

3.03 EXAMINATION

A. Verify existing conditions before starting work.
   1. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of membrane system.
   2. Ensure that substrates are free of standing water, dirt and debris, loose material, voids, and protrusions or deformations which may inhibit application or performance of membrane
   3. Ensure that concrete and masonry substrates are free of voids deeper than 3/8 inch (10 mm) and free of surface protrusions more than 1/4 inches (6 mm) above the surface.
   4. Ensure that the surface of concrete footings to receive the membrane are even and without abrupt changes in plane, with a wood float or better finish.

B. Substrate Tests:
   1. Perform dryness tests recommended by membrane manufacturer.
   2. Test adhesion of membrane to substrate using manufacturer’s recommended test method or as otherwise directed by the Architect.

C. Surface Contaminants:
   1. Verify that form release agents used on vertical surfaces are compatible with membrane products.
   2. Verify that no membrane-forming curing compounds were used on horizontal or other surfaces.
   3. Where curing compounds or incompatible form release agents have been used, remove by blast cleaning down to sound, clean substrate. Acid etching is not acceptable.

D. Do not begin installation until mechanical and electrical items that penetrate membrane are complete and approved.
   1. Verify items which penetrate surfaces to receive membrane are securely installed.
   2. Verify that the distance between individual penetrating items provides clear working distance to effectively install waterproofing. Clusters of penetrating items are not permitted.

E. Verify conformance of Project Conditions with manufacturer's requirements and correct as required.
   1. Report unsatisfactory conditions in writing to the Architect.
   2. Do not install membrane until substrate condition is acceptable to the Contractor, installer, and membrane manufacturer's representative and a written report of the preconstruction inspection has been approved by the Architect.

3.04 PREPARATION FOR LIQUID WATERPROOFING

A. Complete the preparation work specified in this Article, and obtain the Architect's written acceptance of this work prior to installing membrane specified in this section.

B. Remove honeycomb, aggregate pockets, fins, ridges, and projecting rough areas.

C. Reinforced Detail Coating:
   1. Rout or saw-cut cracks wider than 1/16 inch (1.6 mm) to a depth of 1/4 inch (6 mm). Clean groove with compressed air or other suitable means.
   2. Clean cracks less than 1/16 inch (1.6 mm), joints, holes, depressions, and irregularities with compressed air or other suitable means.
   3. Fill cracks, construction joints, holes, depressions, and irregularities per membrane manufacturer's instructions.
   4. Apply reinforced detail coating of liquid membrane extending 6 to 9 inches (150 to 228 mm) in all directions beyond cracks, joints, holes, depressions, and irregularities.

D. Vertical Surfaces at Curbs, Parapets, Walls, and Similar Projecting Elements: Install reinforced liquid membrane detail coating as follows:
   1. Mask off or otherwise protect surfaces to receive sealants, expansion joint materials, or materials other than membrane.
   2. Extend liquid membrane detail coating onto deck not less than 6 inches (150 mm).
   3. Vertical projections:
      a. Curbs less than 24 inches (610 mm) high: Extend liquid membrane detail coating vertically to full height of curbs and across top of curbs and similar projecting elements to join with other building envelope systems.
      b. Parapets 24 inches (610 mm) high and greater: Extend liquid membrane detail coating reinforcement up vertically not less than 6 inches (150 mm).
   4. Walls: Extend liquid membrane detail coating vertically to full height of the wall and join with other building envelope systems. Where waterproofing is not indicated to be carried full height, ensure that membrane extends at least 6 inches (150 mm) above outside finished grade or traffic surface and joins with other building envelope systems.
   5. Laps: Lap edges not less than 4 inches (100 mm). Lap ends not less than 6 inches (150 mm). Form inside and outside corners in accordance with manufacturer's instructions.

E. Footings and Similar Vertical Transitions: Install detail coatings as follows:
   1. Mask off or otherwise protect surfaces to receive sealants, expansion joint materials, or materials other than membrane.
   2. Approximately 6 inches (150 mm) inside of future edge of membrane on footing, provide a fresh saw-cut 1/2 inch (13 mm) deep into concrete footing. Blow out dust and debris with oil-free compressed air.
   3. Apply 12 inch (305 mm)-wide strip of liquid membrane detail coating centered on saw cut.
   4. Form fillet and liquid membrane detail coating at inside corners.

3.05 COLD FLUID-APPLIED MEMBRANE WATERPROOFING INSTALLATION

A. Install membrane in accordance with manufacturer's instructions.

B. Install liquid membrane (one-half of specified thickness unless otherwise specified by manufacturer), embed reinforcing fabric, coat with liquid membrane (one-half of specified thickness unless otherwise specified by manufacturer), and apply protection course / separation sheet according to manufacturer's instructions for the system and thicknesses specified in Part 2 of this Section.

C. At joints and cracks including joints between horizontal and vertical surfaces, apply 12 inch (300 mm) wide strip of joint cover sheet.

D. Center joint cover sheet over joints. Roll sheet into 1/8 inch (3.2 mm) coating of waterproofing material. Apply second coat over sheet extending minimum of 6 inches (150 mm) beyond sheet edges.

3.06 BACKFILLING

A. Backfill promptly after inspection and acceptance of membrane to avoid damage to membrane, insulation, or drainage system.

B. Install soil or other materials in accordance with requirements specified elsewhere, and without damaging waterproofing, insulation, or drainage system.

3.07 FIELD QUALITY CONTROL

A. The membrane manufacturer's representative shall be present at the site to inspect substrates to receive membrane, during installation startup, to troubleshoot during installation when requested by Architect or Contractor, and to approve completed installation.

B. Prior to covering completed membrane with insulation or other materials, inspect all portions of the membrane and flashings.

3.08 PROTECTION AND CLEANING

A. Take measures required to protect completed membrane after installation.

B. Do not permit traffic over unprotected or uncovered membrane.

C. Clean spillage and soiling from adjacent surfaces, using cleaning agents and procedures recommended by the manufacturer of the surface.

FINAL INSPECTION:

I certify that I have inspected the Work specified in this Specification Section within the limit described below. None of this work has been covered by subsequent work, including insulation, drainage mats, backfill, or other materials specified in this section or materials specified in other sections.

The portion of the membrane work that is ready for inspection is as follows (describe portion inspected):

_____

_____

(If subdivided into portions, the sum of such portions shall represent the entire surface of the roof.)

I have inspected this portion of the work specified in this Specificaion Section. I have inspected this work in its entirety prior to its concealment. No segment has been left uninspected. I have found this portion to be complete and in accordance with the Contract Documents. Certified this _____ day of _____, 20___, by

_____(signature)

_____(printed name) on behalf of

_____(Contractor).

CONTRACTOR'S FINAL CERTIFICATE OF INSPECTION

I certify that I have inspected the work specified in this Specification Section. I have inspected this work in its entirety prior to its concealment. No segment has been left uninspected. I have found this work to be complete and in accordance with the Contract Documents. Certified this _____ day of _____, 20___, by

_____(signature)

_____(printed name) on behalf of

_____(Contractor).

END OF SECTION

SECTION 07 21 00 - BOARD AND BATT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Polyisocyanurate Board Insulation:
   1. Exterior walls, beneath cladding.

1.02 REFERENCES

A. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2022.

B. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022.

E. ICC (IBC)-2015 - International Building Code; 2015.

F. ICC (IBC)-2018 - International Building Code; 2018.

G. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.03 SUBMITTALS

A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

B. Shop Drawings:
   1. Illustrate fastener spacing and pattern for securing rigid insulation materials. Coordinate and show fasteners for other materials that penetrate insulation, such as cladding anchors.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 FOAM PLASTIC BOARD INSULATION MATERIALS

A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289.
   1. General:
      a. Board Thickness: As indicated on the drawings.
      b. Surface Burning Characteristics of the insulation and facings tested separately: Flame spread / smoke developed index not greater than 25/450; ASTM E84.
      c. Labeling: Packaging, containers, and insulation shall be labeled as required by ICC (IBC)-2015 / ICC (IBC)-2018 2603.2.
         1) Each piece of insulation shall be labeled as required by ICC (IBC)-2015 / ICC (IBC)-2018 2603.5.6.
      d. Exterior Wall Assemblies: Approved for use by ICC Evaluation Service for Type I, II, III and IV Construction and assemblies of the type employed on this project.
   2. Board for use in or on Exterior Walls:
      a. Tested and meeting the acceptance criteria per ICC (IBC)-2015 / ICC (IBC)-2018 2603.5, including NFPA 285, for Type I-IV Construction.

b. Tested per NFPA 285 for the claddings of the types and configurations used on this project.
   1) Brick or other masonry,
   2) And compliant with the limitations enumerated in the respective ICC-ESR or Engineering Report.

3. Foil Faced Board:
   a. Foil facers; product with perm rating of less than 0.1 perm (5.72 ng/s/sq.m/Pa) ASTM E96/E96M.
   b. Compressive Strength, ASTM D1621: Not less than 25 psi (0.17 MPa).
   c. Acceptable Product:
      1) Atlas Roofing Corporation EnergyShield Pro.
      2) Atlas Roofing Corporation EnergyShield Pro2.
      3) DuPont de Nemours, Inc. Thermax (ci) Exterior Insulation.
      4) DuPont de Nemours, Inc. Thermax Xarmor (ci) Exterior Insulation.
      5) DuPont de Nemours, Inc. Thermax Heavy Duty.
      6) DuPont de Nemours, Inc. Thermax White Finish.
      7) R Max ECOMAXci FR (TSX-8500).
4. Butyl Tape for Exterior Walls: Provide insulation manufacturer's recommended board joint tape for sealing joints, seams and cladding anchor penetrations through the insulation layer. HDPE facer with butyl rubber adhesive; 20 mils (0.5 mm) nominal thickness.
   a. 4 inch (100 mm)-width for insulation board joints.
   b. For framing faces use 4 inches (100 mm)-wide tape. For other project conditions, use wider material as necessary.
   c. Acceptable Products:
      1) DuPont Weathermate Straight Flashing; high-density polyethylene (HDPE) film facer with butyl rubber adhesive.
      2) DuPont Flashing Tape; polypropylene-butyl laminate, 20 mils (0.5 mm) thick.
      3) Typar Butyl Flashing, 20 mils (0.5 mm) thick.
5. Sheathing Tape for Exterior Walls: High-strength, permanent acrylic adhesive, sheathing tape.
   a. Acceptable Products:
      1) DuPont Weathermate Construction Tape.
      2) DuPont Tyvek Contractor Tape.
      3) Typar Construction Tape.
6. Insulation Fasteners: Provide insulated sheathing manufacturer's recommended organic-polymer or other corrosion-protective coated steel screw fasteners for anchoring sheathing to wood studs, metal studs, or masonry and cementitious substrates as applicable. Provide plastic insulation retainer head 1-3/4 to 2 inch (44 to 50 mm) diameter. Fastener length and size based on wall sheathing thickness.
   a. Acceptable Manufacturers:
      1) Wind-lock Corporation; www.wind-lock.com.
      2) Rodenhouse; www.rodenhouse-inc.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation .

B. Verify substrate surfaces are flat, free of honeycomb, fins, or irregularities.

3.02 POLYISOCYANURATE BOARD INSTALLATION ON OUTSIDE FACE OF EXTERIOR WALLS

A. Install insulation in accordance with manufacturer's recommendations.
   1. Space fasteners at not more than 12 inches (305 mm) o.c. at panel perimeter and 16 inches (405 mm) o.c. in panel field. Locate perimeter fasteners 3/8 inch (10 mm) from

panel edge. Perimeter fasteners can also be located on the centerline of abutting board joints due to the 1.75 inch (44 mm) diameter of the washer; a maximum of two boards may be bridged per fastener.

2. Abut panels tightly together and around openings and penetrations.
3. Install sheathing panels horizontally. Use maximum lengths to minimize number of joints.
4. Drive fasteners to bear tight and flush with surface of insulation. Do not countersink.

B. Joint Tape:

1. Apply butyl tape to insulation joints with firm hand pressure, free of wrinkles and fishmouths.
2. Apply butyl tape to seal face of insulation with face of edge closure members and cladding framing.
3. For framing faces up to 3 inches (75 mm) wide, use 4 inches (100 mm)-wide tape. For framing faces over 3 inches (75 mm) wide (such as where double studs occur), use 6 inches (150 mm)-wide tape.
4. Press entire surface area of tape firmly against substrate using 6 inches (150 mm) steel hand roller (4 inches (100 mm) or 6 inches (150 mm) for 4 inches (100 mm) tape) on flat surfaces, or by burnishing with blunt tool such as back of a utility knife on small areas and corners. Continue operation until entire sheet is well bonded to substrate.
5. Where horizontal tape occurs, place an additional layer of sheathing tape on the top horizontal edge of the butyl joint tape; position sheathing tape 2/3's of width on the upper insulation face and 1/3's width on the butyl tape face. Place sheathing tape without wrinkles or fishmouths. Press with a roller as described above.
6. At intersections of vertical and horizontal tape, ensure that tape is weather-lapped to shed water.

3.03 MISCELLANEOUS VOIDS

A. Fill cracks and crevices with insulation. Seal against the passage of air, moisture, dust, and noise.

3.04 PROTECTION OF FINISHED WORK

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

SECTION 07 21 19 - FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

C. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022.

D. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004 (Reapproved 2012).

E. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

F. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2019.

I. ICC ESR - International Code Council Evaluation Service Report; www.icc-es.org/Evaluation_Reports.

1.02 SUBMITTALS

A. Product Data:
   1. Submit manufacturer's product data.
   2. Submit manufacturer's application instructions.
   3. Submit current ICC Evaluation Service Report (ESR). Submittals without a current ICC ESR will not be approved.
   4. Submit test reports demonstrating compliance with NFPA 286 criteria specified.
   5. Indicate the specific foam product and application thickness.
   6. Indicate the specific overcoat product and application thickness in wet and in dry mils.

B. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

C. Installer qualifications.

1.03 QUALITY ASSURANCE

A. Comply with one of the following installer qualifications:

B. Air Barrier Association of America (ABAA) Quality Assurance Program (QAP); www.airbarrier.org/#sle:
   1. Installer Qualification: Use accredited contractor and certified installers.

C. Certification from Spray Polyurethane Foam Alliance; www.sprayfoam.org.
   1. On-site foreman shall hold SPF Master Installer certification.
   2. Not less than one-half of all other on-site personnel shall hold either an SPF Assistant certification of a SPF Installer certification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Regulatory Requirements:
   1. Comply with ICC (IBC) Building Code requirements for foam plastic insulation.
   2. Evaluation Service Report shall list the approved uses required for this Project, including:
      a. Use in Construction Type I-IV construction.
      b. Attics and crawl spaces where entry is made only for service of utilities.
   3. Demonstrate compliance with NFPA 101 Chapter 10; when tested in accordance with NFPA 286, the following criteria shall be met:
      a. Flames shall not spread to the ceiling during the 40 kW exposure.
      b. During the 160 kW exposure, flame shall not spread to the outer extremities of the sample on the 8 x 12 feet (2.45 x 3.65 m) wall, nor shall flashover occur.
      c. Peak heat release rate throughout the test shall not exceed 800 kW.
      d. The total smoke release throughout the test shall not exceed 1,000 m(2).
   4. Surface Burning Characteristics: Flame Spread / Smoke Developed Index of 25/450 maximum, when tested in accordance with ASTM E84.
   5. Air Permeance: 0.04 cfm/sq ft (0.2 L/second sq meter), maximum, when tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.57 psf (75 Pa).

B. Foamed-In-Place Insulation: Low-density, flexible, open celled, water vapor permeable polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
   1. Thermal Resistance: R-value (RSI-value) of 3.0 (0.53), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
   2. Water Vapor Permeance: Vapor retarder; 10 perms (), maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.

C. Overcoat: Where foam is not covered by gypsum wallboard 15-minute prescriptive thermal barrier, provide intumescent coating of the type recommended by the insulation manufacturer and in accordance with foam's ICC ESR and NFPA testing and specific project application.
   1. Provide thermal barrier type coating. Ignition barrier type coating is not acceptable.

2.02 ACCESSORIES

A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify work within construction spaces or crevices is complete prior to insulation application.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

A. Mask and protect adjacent surfaces from over spray or dusting.

B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

A. Apply insulation in accordance with manufacturer's instructions and ICC Evaluation Service Report.

B. Apply insulation to a uniform monolithic density without voids.

C. Apply to achieve a thermal resistance R-value of 49 (RSI-value of ____) to underside of roof deck and framing.

D. Where foam is not separated from interior space by a gypsum wallboard 15-minute thermal barrier, apply overcoat in compliance with manufacturer's recommendations.
   1. Apply thermal barrier type overcoat at not less than the thickness required for thermal barrier properties; application at thickness required for ignition barrier type properties is not acceptable.

E. Patch damaged areas.

F. Where applied to voids and gaps, install using methods to ensure space for expansion to avoid pressure on adjacent materials that may bind operable parts.

G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

SECTION 07 25 30 - WEATHER-RESISTANT BARRIER (ADHESIVE SHEET)

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Water-Resistive Barrier: Materials to keep liquid water from passing through exterior walls, joints between exterior walls and roof, joints around frames of openings in exterior walls, and joints around penetrations through exterior walls.

B. Vapor Barrier: Materials to keep water vapor from passing through exterior walls, joints between exterior walls and roof, joints around frames of openings in exterior walls, and joints around penetrations through exterior walls.

C. Air Barrier: Materials to keep air from passing through exterior walls, joints between exterior walls and roof, joints around frames of openings in exterior walls, and joints around penetrations through exterior walls.

1.02 SYSTEM DESCRIPTION

A. Install sheet materials to form a secondary weather barrier to direct water penetrating the exterior cladding down and out to the exterior.

B. Extend sheet materials across joints and seams in similar and dissimilar substrates and around doors, windows, and other openings to form a continuous barrier against intrusion of water and air.

1.03 SUBMITTALS

A. Product Data: Indicate material characteristics, performance criteria, and limitations.

B. Manufacturer's Installation Instructions: Indicate preparation, installation methods, storage requirements, and temperature limitations during and after installation.

C. Shop Drawings: Provide drawings of special joint conditions.

D. Reports: Submit reports signed by Contractor, installer, and membrane manufacturer's representative of:
   1. Preapplication review.
   2. Completion inspections.

E. Warranty.

1.04 QUALITY ASSURANCE

A. Preapplication Review: Schedule a meeting before start of installation with installer and waterproofing manufacturer's representative to review procedures for substrate preparation and waterproofing application.
   1. Review contract document requirements, manufacturer's product data, and application instructions.
   2. Manufacturer’s representative shall instruct first-time installers in proper installation procedures, and shall be available throughout project for trouble shooting upon request.

B. Install sheet materials in mock-ups specified elsewhere.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer’s original unopened containers.

B. Store containers in a dry location at temperatures under 100 deg.F (38 deg.C). Do not double-stack pallets.

C. During cold weather installation (under 60 deg.F (15.5 deg.C)), store sheet in heated enclosure (70 to 90 deg.F (21 to 32 deg.C)) 12 hours prior to installation; Remove only such material as is needed for immediate use.

D. Do not install material when substrate temperature is under 40 deg.F (4 deg.C) unless special procedures recommended by the manufacturer are followed and successful adhesion is obtained and mock-ups are approved by the Architect.

E. Do not expose to sunlight for more than 30 days, either when in storage or after installation, before covering with subsequent construction.

1.06 SEQUENCING

A. Backing Strip: Ensure that backing strip is installed before installing gypsum sheathing.

1.07 WARRANTY

A. Provide Special Project Warranty specified in Section 01 78 10 - Special Project Warranty on Roofs and Walls.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS

A. Provide products of one of the following:
   1. GCP Applied Technologies
   2. Carlisle Coatings & Waterproofing Inc.
   3. W. R. Meadows Inc.
   4. Henry.
   5. Tremco.

2.03 MATERIALS

A. Self-Adhesive Wall Membrane:
   1. Composite material: Rubberized asphalt bonded to high density polyethylene film; 40 mils (1.0 mm) total thickness.
   2. Release sheet to protect adhesive layer.
   3. Product:
      a. GCP Applied Technologies; Perm-A-Barrier Wall Membrane.
      b. Carlisle Coatings & Waterproofing Inc.; CCW-705 Self Adhering Vapor/Air Barrier.
      c. W. R. Meadows Inc.; Air Shield Air Barrier and Flashing Membrane.
      d. Henry: Blueskin SA.
      e. Tremco: ExoAir 110.

B. Termination Mastic:
   1. Trowel or caulking grade rubberized asphalt-based mastic.
   2. Products:
      a. GCP Applied Technologies; Bituthene Mastic.
      b. Carlisle Coatings & Waterproofing Inc.; Barribond or LM 800 XL.
      c. W. R. Meadows Inc.; Seal Tight Pointing Mastic.
      d. Henry: Air-Bloc 06 Trowel Grade.
      e. Tremco: Dymonic FC.

C. Solvent Base Primer:
   1. Rubber-based, solvent dispersed liquid for substrate preparation.
   2. Products:
      a. GCP Applied Technologies; B2 Low VOC Content Primer.
      b. Carlisle Coatings & Waterproofing Inc.; CCW 702 Primer.
      c. W. R. Meadows Inc.; Mel Prime Solvent Based Primer.
      d. Henry: Blueskin LVC Adhesive.
      e. Tremco: ExoAir 10 Primer.

D. Termination Bar: Extruded aluminum or formed stainless steel, pre-punched with slotted holes at 8 inches (203 mm) o.c. for fasteners.
   1. Fasteners for bar on stud back-up: For steel studs #12 screws with Type 304 stainless steel head and shaft, carbon steel tip; for wood studs Type 304 stainless steel nails or screws.
   2. Fasteners for bar on concrete or masonry back-up: Stainless steel drive pins with lead expansion shields.
   3. Backing Strip for stud and sheathing substrates: Galvanized steel sheet metal, 4 inches (100 mm) wide.

PART 3 - EXECUTION

3.01 BACKING STRIP

A. When cold formed metal framing installation is complete and before installing gypsum sheathing, install backing strip to face of studs in a continuous fashion, directly behind the location where termination bars will be installed.

3.02 EXAMINATION AND PREPARATION

A. Review installed substrate surfaces for compliance with preparation requirements. Document necessary actions for correcting unacceptable surface conditions.

B. Verify that surfaces are smooth, sound, clean, and dry, and that components which will penetrate self-adhesive sheet are complete and rigidly installed.

C. Temperature: Install primer and sheet when temperature of substrate is 40 deg F (4 deg C) or above.

D. Do not install sheet until substrate condition is acceptable to the Contractor, installer, and sheet manufacturer's representative.

E. Concrete Substrates:
   1. Verify that form release agents or curing compounds used on surfaces are compatible with sheet products.
   2. Where incompatible products have been used, remove in accordance with sheet manufacturer's instructions.
   3. Remove dust and chalk from substrates by dry brushing or pressure washing. Allow surface to dry thoroughly.
   4. Remove and repair honeycomb, aggregate pockets, fins, ridges, and projecting rough areas.
   5. Apply primer on same day as sheet installation, and allow to dry.

F. Sheathing Substrates:
   1. Remove dust from substrates by dry brushing.
   2. Apply primer and allow to dry.

3.03 INSTALLATION

A. General:
   1. Precut pieces of sheet to required size for proper installation and ease of handling.
   2. Remove release paper and position sheet against substrate.
   3. Press entire surface area of sheet firmly against substrate using 6 inches (150 mm) steel hand roller on flat surfaces, or by burnishing with blunt tool such as back of a utility knife on small areas and corners. Continue operation until entire sheet is well bonded to substrate.
   4. Plan installation generally from bottom to top. Overlap adjacent pieces 2 inches (50 mm), forming laps that shed water, not dam water.
   5. Roll or burnish laps to ensure complete adhesion.
   6. Apply a bead of mastic on laps and perimeter of sheet.
   7. Seal unavoidable penetrations with mastic.

8. Do not contaminate substrates to receive sealant with primers, surface conditioner, or self-adhesive sheet material.
9. Apply mastic on top of sheets, only. Do not apply sheet on top of mastic.

B. Detailing at Window, Door, Louver, and Other Openings:
1. Wrap sheet into opening a sufficient distance to ensure contact with the inboard air seal (joint sealant) between the sheet and the frame of the window, door, louver, etc., and to form a back dam against water intrusion.
2. Wrap sheet onto the outside face of the wall as recommended by membrane manufacturer, but in no case less than 3 inches (75 mm) on to face of wall.

C. Self-Adhesive Wall Membrane:
1. Install over the entire wall surface in accordance with general instructions, above.
2. Termination Bar: Install termination bar where top of membrane terminates against back-up construction and membrane is otherwise unsupported by mechanical fasteners. Secure bar to back-up with mechanical fasteners at 8 inches (200 mm) on center. Seal outside edge with termination mastic.
3. Where termination bars occur over gypsum sheathing, ensure that fasteners penetrate backing strip.

3.04 FIELD QUALITY CONTROL

A. Just prior to covering, inspect weather-resistant barrier to ensure that it forms a continuous, uninterrupted barrier over the entire wall surface in full compliance with this specification and the manufacturer's installation instructions. Ensure that the barrier is undamaged by exposure, weather, or other inadvertent damage.

B. Notify the Architect when Contractor's inspection is complete.

C. Do not cover installed weather-resistant membrane until required inspections have been completed.

3.05 CLEANING AND PROTECTION

A. Protect adjacent surfaces from contamination by surface conditioners, primers, or residue from bituminous sheet.

B. Remove spills, stains, or over-application in accordance with manufacturer’s recommendations.

C. Protect installed material from damage. Repair any damage to sheet promptly.

D. If schedule of construction would unavoidably expose sheet materials to sunlight for more than 30 days, cover materials to avoid exposure to sunlight, unless approved in writing by the Architect and the Manufacturers Representative.

END OF SECTION

SECTION 07 25 40 - UNDERLAYMENT FOR STEEP-SLOPE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES:

1.02 SYSTEM DESCRIPTION

A. Install sheet materials to form a secondary weather barrier to direct water penetrating the exterior skin down and out to the exterior.

B. Extend sheet materials across joints and seams in similar and dissimilar substrates and around doors, windows, and other openings to form a continuous barrier against intrusion of water and air.

1.03 SUBMITTALS

A. Product Data:

1. For approval: Written technical product information for each type of product to demonstrate products comply with contract documents. Provide all products of this section from one manufacturer.
2. For information (Project record): Manufacturer's detailed installation instructions. No provision of such instructions shall be deemed to delete any requirement of the Contract Documents without the approval of the Architect issued as a Contract Modification.

1.04 QUALITY ASSURANCE

A. Preapplication Review: Schedule a meeting before start of installation with installer and waterproofing manufacturer's representative to review procedures for substrate preparation and waterproofing application.

1. Review contract document requirements, manufacturer's product data, and application instructions.
2. Manufacturer’s representative shall instruct first-time installers in proper installation procedures, and shall be available throughout project for trouble shooting upon request.

B. Install sheet materials in mock-ups specified elsewhere.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer’s original unopened containers.

B. Store containers in a dry location at temperatures under 100 deg F (38 deg C). Do not double-stack pallets.

C. During cold weather installation (under 60 deg F (15.5 deg C)), store sheet in heated enclosure (70 to 90 deg F (21 to 32 deg C)) 12 hours prior to installation; Remove only such material as is needed for immediate use.

D. Do not install material when substrate temperature is under 40 deg F (4.5 deg C) unless special procedures recommended by the manufacturer are followed and successful adhesion is obtained and mock-ups are approved by the Architect.

E. Do not expose to sunlight for more than 30 days, either when in storage or after installation, before covering with subsequent construction, unless otherwise approved by the manufacturer.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Carlisle Coatings & Waterproofing Inc.

B. GCP Applied Technologies.

C. Henry.

2.03 MATERIALS

A. Self-Adhesive Roofing Underlayment:
   1. Composite material: Rubberized asphalt bonded to high strength polyethylene film; 40 mils (1.0 mm) total thickness.
   2. Release sheet to protect adhesive layer.
   3. Product:
      a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT Water & Ice Protection Self Adhering Roofing Underlayment.
      b. GCP Applied Technologies; Grace Ice & Water Shield.
      c. Henry: Blueskin RF200.

B. Water Base Primer:
   1. Latex-based, water-dispersed liquid for substrate preparation.
   2. Products:
      a. Carlisle Coatings & Waterproofing Inc.; CCW 501SP Self Priming Basecoat.
      b. GCP Applied Technologies; Perm-A-Barrier Surface Conditioner WB.
      c. Henry: Aquatac Primer.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Review installed substrate surfaces for compliance with preparation requirements. Document necessary actions for correcting unacceptable surface conditions.

B. Verify that surfaces are smooth, sound, clean, dust-free, and dry, and that components which will penetrate self-adhesive sheet are complete and rigidly installed.

C. Employ manufacturer's primer when recommended by membrane manufacturer.

D. Temperature: Install material when temperature of substrate is 40 deg F (4.5 deg C) or above.

E. Do not install sheet until substrate condition is acceptable to the Contractor, installer, and sheet manufacturer's representative.

3.02 INSTALLATION

A. General:
   1. Precut pieces of sheet to required size for proper installation and ease of handling.
   2. Remove release paper and position sheet against substrate.
   3. Vertical surfaces: Press entire vertical surface of sheet firmly against substrate using 4 to 6 inches (100 to 150 mm) steel hand roller on flat surfaces, or by burnishing with blunt tool such as back of a utility knife on small areas and corners. Continue operation until entire area is well bonded to substrate.
   4. Overlap edges not less than 3-1/2 inches (88 mm) and ends not less than 6 inches (150 mm).
   5. Plan installation generally from bottom to top. Form laps that shed water, not dam water.
   6. Roll or burnish laps to ensure complete adhesion.
   7. Apply a bead of mastic on laps and perimeter of sheet.
   8. Seal unavoidable penetrations with mastic.
   9. Do not contaminate substrates to receive sealant with primers, surface conditioner, or self-adhesive sheet material.

B. Self-Adhesive Roofing Underlayment:
   1. At valleys, place a 36 inches (914 mm)-wide strip centered along the valley, then install field membrane lapping on top of the valley strip.
   2. At eaves and rakes, install an 18 inches (455 mm)-wide strip along eaves and rakes extending over the fascia the width of the vertical edge metal less one inch or so. Install the edge metal (specified elsewhere in Division 07) on top of the 18 inches (457 mm)-wide

membrane strip. Then install field membrane lapping on top of the sky-facing face of the edge metal and sealing fasteners through the metal.

3. Install underlayment over the entire roof surface.
4. At hips and ridges, after installing field membrane, install an 18 inches (457 mm)-wide strip centered along the hips and ridges.

3.03 FIELD QUALITY CONTROL

A. Inspect installation before covering with subsequent construction.

3.04 CLEANING AND PROTECTION

A. Protect adjacent surfaces from contamination by surface conditioners, primers, or residue from bituminous sheet.

B. Remove spills, stains, or over-application in accordance with manufacturer’s recommendations.

C. Protect installed material from damage. Repair any damage to sheet promptly.

D. If schedule of construction would unavoidably expose sheet materials to sunlight for more than 30 days, cover materials to avoid exposure to sunlight, unless approved in writing by the Architect and the Manufacturers Representative.

END OF SECTION

SECTION 07 26 00 - VAPOR RETARDERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vapor retarders.

1.02 DEFINITIONS

A. Vapor Retarder: Airtight barrier made of material that is relatively water vapor impermeable, to degree specified, with seams and joints sealed to adjacent surfaces.

B. Vapor Retarder Class: A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class is defined using Procedure A, Desiccant Method at 73 degrees F (23 degrees C) and 50 percent Relative Humidity (RH), in accordance with ASTM E96/E96M and ICC (IBC)-2018, as follows:
   1. Class I: 0.1 perm or less.
   2. Class II: Greater than 0.1 perm to 1.0 perm.
   3. Class III: Greater than 1.0 perm to 10 perms.

1.03 REFERENCE STANDARDS

A. ASTM D1709 - Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method; 2016a, with Editorial Revision (2017).

B. ASTM D3776/D3776M - Standard Test Methods for Mass Per Unit Area (Weight) of Fabric; 2020.

C. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting; 2018.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022.

E. ICC (IBC)-2018 - International Building Code; 2018.

1.04 SUBMITTALS

A. Product Data: Provide data on material characteristics, performance criteria, and limitations.

B. Shop Drawings: Provide drawings of special joint conditions.

C. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 VAPOR RETARDERS

A. Reinforced Vapor Retarder: Class I membrane.
   1. Material: 5-ply laminate, combining three (3) layers of linear low density polyethylene and two (2) non-woven cord grids.
   2. Weight: ASTM D3776/D3776M, 62 lb/1,000 sq ft (31.2 kg/100 sq m).
   3. Water Vapor Permeance: 0.022 perm (1.06 ng/(Pa s sq m)), maximum, when tested in accordance with ASTM E96/E96M.
   4. Drop Dart, ASTM D1709, 1,100 g.

5. Tensile Strength: 4,000 psi (27.58 MPa), minimum, measured in accordance with ASTM D882 and at grip-separation rate of 3 inches (75 mm) per minute.
6. Usable Temperature Range: Minus 40 to 170 degrees F (Minus 40 to 77 degrees C).

2.03 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Vapor Retarder and Adjacent Substrates: As indicated, complying with vapor retarder manufacturer's installation instructions.

B. Vapor Retarder Tape: Manufacturer's standard.
1. Description: Black, double-sided, asphaltic, pressure-sensitive, mastic tape.
2. Thickness: 35 mils (0.9 mm).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions comply with requirements of this section.

3.02 PREPARATION

A. Remove projections, protruding items, and loose or foreign matter and debris that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.03 INSTALLATION

A. Install materials in accordance with manufacturer's installation instructions.

B. Install vapor retarders continuously at locations in crawl space indicated on drawings. Ensure there are no discontinuities at seams and penetrations.

C. Install vapor retarders in largest practical widths.

D. Join sections of vapor retarder and seal penetrations in vapor retarder with tape. Ensure surfaces to receive tape are clean and dry.

E. Immediately repair holes in vapor retarder membrane with tape recommended by manufacturer.

F. Seal around piers, pipes and other penetrations in accordance with manufacturer's instructions.

3.04 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION

SECTION 07 31 26 - SLATE SHINGLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Slate roofing shingles.
   1. Quantity of shingles salvaged from existing roof is expected to be approximately 50 percent. Base Bid quantity of new slate roof shingles shall provide 50%.

B. Water-resistant underlayment.

C. Metal roof flashing.

1.02 RELATED REQUIREMENTS

A. Section 07 62 00 - Sheet Metal Flashing and Trim.

1.03 REFERENCE STANDARDS

A. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2022.

B. ASTM C406/C406M - Standard Specification for Roofing Slate; 2015.

C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

D. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.

E. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.

F. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).

G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022.

H. AWPA U1 - Use Category System: User Specification for Treated Wood; 2022.

I. NRCA (RM) - The NRCA Roofing Manual; 2022.

1.04 SUBMITTALS

A. Product Data: Manufacturer's data sheets on slate roofing, including material characteristics, application limitations, and recommendations for installation and quarry source.

B. Provide ASTM C406 Test report on the proposed slate material indicating classification grade.

C. Shop Drawings: Details for specially configured metal flashing, joint configurations, and flashing locations.

D. Selection Samples: Actual pieces of slate shingles representing full range of available colors and finishes, for selection by Architect.

E. Verification Samples: Actual shingles in each selected color and finish, illustrating full range of color and texture variation to be anticipated in the finished work.

F. Installer's qualification statement.

G. Specimen warranty.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements for additional provisions.
   2. Extra Shingles: Quantity equal to 3 percent of total installed, but not less than one full carton.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain slate required for this project from one quarry with adequate resources to ensure consistent quality and appearance for project.

B. Installer Qualifications: Company specializing in installing slate roofing, with at least three years of documented experience.

1.06 MOCK-UPS

A. See Section 01 40 00 - Quality Requirements for additional requirements.

B. Provide a mock-up for evaluation of overall installed appearance.
   1. Apply slate shingles to specified pattern in location designated by Architect.
   2. Minimum size of mock-up is 100 sq ft (9.3 sq m).
   3. Do not proceed with remaining work until workmanship and overall appearance and pattern are approved by Architect.
   4. Approved mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver shingles to project site in fabricator's unopened crates or cartons, clearly labeled and identified.

B. Handle shingles to avoid chipping, breakage, soiling, or other damage. Protect edges with wood or other cushioning and protective material.

C. Stack skids and slate cartons to distribute weight evenly and to avoid breakage or cracking.

D. Immediately prior to installation, distribute stacked slate shingles on roof to facilitate installation and to avoid overloading roofing substrate.

1.08 FIELD CONDITIONS

A. Do not install shingles or eave protection membrane when surface temperatures are below 45 degrees F (7 degrees C).

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for defective materials and workmanship. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Slate Shingles:
   1. Vermont Structural Slate Company, Inc; Grayson Slate, by James River Slate Company (subsidiary of Vermont Structural Slate): www.vermontstructuralslate.com/#sle.
   2. Buckingham Slate Company; www.buckinghamslate.com/#sle.
   3. Black Diamond Slate, LLC; www.blackdiamondslate.com/#sle.

2.02 ROOFING MATERIALS

A. Slate Shingles: Hard, dense, sound rock, free of ribbons.
   1. Type: Traditional; drilled or punched with two nail holes per shingle, located for headlap as specified under installation.
   2. Classification: Grade S1, expected service life over 75 years, complying with ASTM C406/C406M.
   3. Texture: Rough
   4. Thickness: To match existing to be reused.
   5. Length: To match existing to be reused.
   6. Width: To match existing to be reused.
   7. Butt Shape: To match existing to be reused.
   8. Color: Unfading, color to match existing roofing.
   9. Slates to be applied with standard head lap to match existing, based on matching existing slate size and existing slope of roof.
   10. Starter Slate: Slate shingles with chamfered nail holes front-side punched.

a. Length: Exposure of slate shingles plus head lap.

B. Underlayment: Self-adhering polymer-modified sheet; 40 mil (1.016 mm) total thickness; with strippable siliconized release film on bottom side and slip resistant and UV-stable facing on top side.
   1. Water Vapor Permeance: 30 perm (1716 ng/(Pa s sq m)), when tested in accordance with ASTM E96/E96M Procedure A (desiccant method).
   2. Products:
      a. W.R. Grace & Co; Product - Grace Ice and Water Shield HT.

C. Slip Sheet: Rosin sized building paper.

D. Eave Protection Membrane: Self-adhering polymer-modified asphalt sheet complying with ASTM D1970/D1970M; nominal total thickness of 40 mil, 0.040 inch (1.0 mm); with strippable release paper and polyethylene sheet top surface.

2.03 ACCESSORIES

A. Flashing:
   1. Copper: ASTM B370 copper, cold rolled, 16 oz/sq ft (0.56 mm thick).

B. Attachment Members:
   1. Material: Pressure preservative treated wood complying with AWPA U1 Use Category UC3B, Commodity Specification A (Treatment C2) using waterborne preservative to 0.25 lb/cu ft (4.0 kg/cu m) retention.
   2. Nailers: Nominal 2 inches (50 mm) wide by 1-inch (25 mm) thick members, or thickness as required for specific conditions.
   3. Cant Strips: Beveled strips, nominal size as indicated, nominal 48 inches (1220 mm) long and spaced nominal 1/2 inch (12.5 mm) apart at ends for drainage.

C. Nails: Slater's large-headed copper ring shank nails, length not less than twice slate thickness plus underlayment and 1 inch (25 mm), or long enough to penetrate completely through roof sheathing.
   1. Base selection of nails on mock-ups performed by Contractor and Architect in field. Evaluate the following for use:
      a. 10 gauge copper, ring-shank, large-head nails.
      b. 10 gauge stainless steel, smooth-shank, large-head nails.
      c. If 10 gauge nails bend, test 9 gauge stainless steel, smooth-shank nails.

D. Asphalt Flashing Cement: For use as adhesive dabs below hip and ridge slates:
   1. Trowel grade cement containing non-asbestos stabilizers or fibers complying with ASTM D4586/D4586M.

E. Butyl Sealant: ASTM C1311 one-part non-sag polymerized butyl sealant.

F. Sealant: ASTM C920 low-modulus silicone joint sealer.

G. Slate Hooks for Slate Repair Work: For slates with a 3-inch headlap and measuring up to 3/4 inch thick; 3-inches long, 10-gauge solid copper, Type 304 stainless steel, or Type 304 stainless steel powder coated black or bronze with 3/8-inch hook or 3/4-inch hook.

H. Metal Ridge and Hip Accessories: As indicated on drawings, same material as exposed flashings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roofing accessories and roofing penetrations are complete and properly flashed.

B. Verify that roof openings are correctly framed.

C. Verify that roof deck surfaces are dry and free of ridges, warping, and voids.

3.02 SALVAGE AND REUSE

A. Take necessary steps and precautions to remove, carefully clean, visually evaluate and ring (sound test), stock, store (on edges - do not stack flat), and protect existing slate for reinstallation or for Owner's salvage as directed by Owner. Discard cracked, split, chipped, or weathered internally deteriorated) slates.

3.03 PREPARATION

A. Prepare deck surfaces using methods recommended by slate shingle and underlayment manufacturer for existing project conditions.

B. Broom clean roof deck thoroughly prior to beginning installation.

3.04 INSTALLATION

A. Install slate shingle roofing system in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.

B. Sheet Metal Flashing: Install flashing as indicated and as required by project conditions.
   1. Install flashing at each location where slate roof intersects other roofs, walls, parapets, chimneys, ventilators, and similar projections.
   2. Fabricate flashings at open valleys with standing rib at center of valley, not less than 1 inch (25 mm) high; extend flashing not less than 12 inches (305 mm) onto roof deck on each side of valley.
   3. Attach shingles at valleys using copper wires to copper straps nailed beyond edge of flashing sheets.
   4. Install drip edge flashing at eaves prior to installing underlayment.
   5. Install metal ridge cap in accordance with NRCA details and recommendations.

C. Underlayment:
   1. Install underlayment over entire deck surface. At select locations including ridges and valleys, there use 2 layers of underlayment. Provide felt underlayment over self-adhering sheet to prevent slate from sticking to underlayment. Apply additional layer of underlayment not less than 36 inches (914 mm) wide at valleys.
   2. Ice Dam Protection: Install eave protection membrane at eaves, extending to a line that when projected to the horizontal is not less than 24 inches (610 mm) inside of interior wall line.

D. Wood Attachment Members:
   1. Cants: Install cant strips at eaves on top of underlayment, spaced for drainage.
   2. Nailers: Install nailers at ridge and hips, directly over underlayment. Protect with additional layer of underlayment before installing ridge and hip slates and accessories.

E. Slate Shingles:
   1. Double shingles at eaves and cornice line. Beginning at built in gutter, project shingles minimum uniform dimension of 1 inches (25.4 mm) and lay shingles in horizontal courses. Install shingles with minimum of 4-inch (102 mm) headlaps, and stagger joints between courses a minimum of 3 inches (76 mm). Project shingles minimum uniform dimension of 1 inch (25.4 mm) at gables.
   2. Cut and fit shingles neatly around vents, pipes, and other projections.

3.05 CLEANING

A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.

B. Clean exposed work upon completion of installation; remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to finish.

3.06 PROTECTION

A. Minimize and prevent traffic over finished roof surface, and when necessary wear soft-soled shoes and walk on butt or tab of slate shingles to avoid breakage.

B. Remove and replace damaged or broken slate shingles before Date of Substantial Completion.

END OF SECTION

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Sheet metal flashing, trim, closures, covers, clips, etc.
   2. Gutter liners.
   3. Fasteners and attachment devices.
   4. Joint sealants in contact with work of this Section.
   5. Coatings and slip sheets to isolate sheet metal from dissimilar materials.

1.02 REFERENCES

A. ASTM A370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products; 2021.

B. ASTM B32 - Standard Specification for Solder Metal; 2020.

C. CDA A4050 - Copper in Architecture - Handbook; current edition.

1.03 SYSTEM DESCRIPTION

A. Sheet metal work includes exposed and concealed flashing, trim, and other sheet metal fabrications specified in this section, indicated on the Drawings, and as required by project conditions. Only the general arrangement and configuration of sheet metal work is indicated on the drawings.

B. Fabricate join, and fasten sheet metal work in conformance with manufacturer's recommendations and recommendations of CDA A4050 to accommodate the project conditions on the site, and without change in Contract Time or Price. Such details shall conform to the CDA recommendations for maximum life and reliability.

C. Such details shall provide:
   1. Expansion provisions for running work.
   2. Sheet metal work that can reasonably be expected to be leak-free for at least 20 years without maintenance.
   3. Weather-proof performance without relying on sealant.
   4. Exception: Where the use of joint sealant is required by the Contract Documents or is required by Project conditions and is approved in writing by the Architect.

D. Seams and Joints: Where specific types of seams and joints are not indicated in the Contract Documents, select seams and joints in the order that follows:
   1. Provide locked seam or joint where, due to slope and interlocking of seam, the seam or joint is inherently weather-proof without the use of solder or sealants.
   2. Provide locked and soldered seam or joint where slope and interlocking of seam would allow water penetration, and where rigid construction is required. Prepare edges to be seamed, form seams, and solder.
   3. Provide sealant-filled expansion seams or joints only where lapped or bayonet-type expansion provisions in work cannot be used, or would not be water-and-weather-proof Obtain the written authorization of the Architect in each case. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant concealed within joints.

E. Fastening:
   1. Employ concealed cleats to fasten sheet metal to the substrate.
   2. Do not fasten exposed fabrications directly to the substrate unless explicitly required by the Specifications or the Drawings.
   3. Employ concealed fasteners. Obtain the Architect’s written authorization where exposed fasteners are proposed.
   4. Ensure exposed fasteners are permanently sealed against water penetration.

1.04 SUBMITTALS

A. Product Data for each material.

B. Installer qualifications: Submit for Architect's approval within the time limits specified.

C. Shop Drawings:
1. Metal component profiles.
2. Joints and seams.
3. Joint and seam pattern.
4. Fastening methods.
5. Accessory items.
6. Relationship of materials to adjacent construction.

1.05 QUALITY ASSURANCE

A. Installer: A company with at least 15 years of experience with installing products included in this section and which has completed at least 20 installations similar in scope to work included in this section.
1. Submit the names of at least 3 projects within 30 miles (48 km) of the project site. Include project name, date of completion, name and telephone of owner contact, name and telephone of architect contact.
2. Submit within the time limits specified in the Bidding Requirements and General Conditions.

B. Preconstruction Mock-ups:
1. Construct mock-ups so as to demonstrate on site all aspects of preparation, fabrication, and installation of sheet metal work and its relationship to adjacent materials.
a. Provide metal flashings and trim for mock-ups specified in other specification sections such as wall cladding, windows and glazing, and roofing.

C. Quality Standard:
1. Fabricate and install metal work in accordance with CDA A4050 recommendations.

1.06 DELIVERY, STORAGE AND HANDING

A. Follow metal manufacturer's recommendations for avoiding staining and marring of sheets.

B. Do not allow traffic of any kind on work.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Copper Sheet: ASTM A370, H00 temper.
1. Temper: H00 "cold-rolled".
a. General use, unless otherwise indicated.
2. Weight of Copper Sheet:
a. 16 oz/sq.ft. (4882 g/sq m), unless otherwise indicated.
b. All Other Running Trim: 20 oz/sq.ft. (6103 g/sq m).

2.03 ACCESSORY MATERIALS

A. Fasteners for Job Fabrications:
1. Fasteners for Masonry Substrates: Type 304 stainless steel expansion type fasteners requiring pre-drilled hole. Powder or impact type fasteners not acceptable.
2. Fasteners for Steel Substrates: Self-drilling, self-tapping screws with hardened carbon steel tip, Type 304 stainless steel shank. Provide dome head with neoprene washer where exposed fasteners are approved in writing by the Architect.
3. Fasteners for Copper Sheet:

a. Nails: Copper or hardware bronze, 0.109 inch (2.7 mm) minimum x not less than 7/8 inch (22 mm) long; barbed with large head.
b. Screws and bolts: Copper, bronze, or brass.
c. Fixed cleats: Copper sheet; 2 inches (51 mm) wide 3 inches (76 mm) long.
d. Expansion cleats: Copper sheet, size and configuration as indicated in CDA A4050 detail 4.1.4.
e. Cleat gauge: Fabricate cleats from metal of gauge equal to the metal being fastened.
f. Tinner's rivets: Solid; one-piece copper; 3/16 inch (5 mm) diameter shank; with copper washer.
g. Pop Rivets: Copper with copper drive pins. Pop rivets shall not be used without the written permission of and at the sole discretion of the Architect, which permission may or may not be granted. Pop rivets are not usually permitted, and only occasionally are deemed to be useful.

B. Solder: ASTM B32.
1. For copper sheet: 50/50 tin-lead solder; rosin flux.

C. Sealants in contact with Work of this Section:
1. Concealed joints.
a. Mastic sealant: Butyl sealant as specified in Section 07 92 00 - Joint Sealants.
b. Butyl polyisobutylene sealant tape: As specified in Section 07 92 00 - Joint Sealants.
2. Exposed joints: Silicone as specified in Section 07 92 00 - Joint Sealants.

D. Slip Sheet: Rosin-sized paper, 5 lb (454 g) nominal weight.

2.04 FABRICATION

A. Shop and Field Fabrication:
1. Shop fabricate work to the greatest extent possible.
2. Form work to fit substrate.
3. Form sheet metal to match profiles indicated, substantially free from oil-canning, buckling, tool marks, fish-mouths, and other defects.

B. Fasten sheet metal with concealed cleats. Fabricate cleats and attachment devices from same material as sheet metal component being anchored. Employ exposed fasteners only where and if specifically approved in writing by the Architect.

C. Form a 1/2 inch (13 mm) hem on underside of exposed edges.

D. Fabricate components to match profiles and details indicated and to ensure permanently leakproof construction. Provide for thermal expansion of sheet metal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which products of this section are to be installed and verify that work may properly commence. Do not proceed with the work until unsatisfactory conditions have been fully resolved.
1. Verify that nailers, blocking, and other attachment provisions for sheet metal work are properly located and securely fastened to resist effects of wind and thermal stresses.

3.02 PREPARATION

A. Coordinate sheet metal roofing with other sheet metal work and substrate construction to provide a complete and permanently water-tight installation.

B. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Clean surfaces to receive sheet metal work. Verify that substrates are smooth and free of protrusions, irregularities, or other defects.
1. Drive nails or other fasteners flush with substrate.

D. Coat the back side of metal with bituminous coating where it will be in contact with wood, dissimilar metal, or cementitious construction unless surfaces will be separated by self-adhesive underlayment or similar material.

3.03 INSTALLATION

A. Comply with CDA A4050 recommendations.

B. General:
   1. Fabricate and install work with lines and corners of exposed units true and accurate.
   2. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks considering temper and reflectivity of metal.
   3. Provide uniform, neat seams with minimum exposure of solder and sealant.
   4. Fold back sheet metal to form a hem on concealed side of exposed edges.
   5. Conceal fasteners and expansion provision where possible in exposed work, and locate so as to minimize possibility of leakage.
   6. Cover and seal fasteners and anchors.

3.04 SEAMS AND JOINTS

A. General: Wherever practicable select joints that are permanently, inherently weather-tight and allow for thermal movement, and do not rely on solder or sealant for their integrity. Otherwise, use soldered joints wherever movement is not essential (except where aluminum or Kynar metals are required). Avoid the use of sealant joints except where movement must be accommodated.

B. Lapped Seams, Soldered and Riveted: Rivet and solder joints for additional strength where indicated or where recommended by CDA A4050. Ensure that copper is properly prepared to bright metal, and tinned. Form a 1-1/2 inch (38 mm)-wide lap; provide 1 row of tinner's rivets 1/2 inch (13 mm) from edge; pre-punch holes spaced at 2 inches on center; provide a second row of rivets 1/2 inch (13 mm) from opposite edge of lap, staggered with first row. Ensure that copper is properly prepared to bright metal, and tinned. Peen rivets securely against washers. Solder a fully-sweated, water-tight lap.

C. Expansion Provisions: Where lapped or bayonet-type expansion provisions in work cannot be used, or would not be water-and-weather-proof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant concealed within joints.

D. Sealant Joints: Where movable, non-expansion-type joints are indicated or required for proper performance of roofing, form sheet metal to provide for proper installation of elastomeric sealant as recommended by referenced standards.

E. Soldered Seams and Joints in Copper Sheet:
   1. Clean surfaces to be soldered, removing oils and foreign matter.
   2. Abrade sheets to bright metal before soldering.
   3. Neatly pre-tin edges of sheets to be soldered in a bath unless configuration prohibits the use of a bath; pretin in situ using heated soldering coppers only where detailed work cannot be tinned in a bath. Pre-tin to a width of 1-1/2 inch (38 mm).
   4. Ensure that pre-tinned surfaces are soldered up as permanent work on the same day as pre-tinning occurs. Do not use pre-tinned surfaces that were tinned the previous day.
   5. Employ heavy, heated soldering coppers to solder seams. Do not use direct flame torches for soldering.
   6. Heat surfaces to receive solder and flow solder into joint. Fill joint completely.
   7. Remove flux and solder spatter from exposed surfaces. Neutralize acidic flux with baking soda and fresh water.
   8. Cover exposed and concealed surfaces to protect from corrosive spray when soldering coppers are dipped to clean.

F. Moving Joints:
   1. When ambient temperature is moderate (40 - 70 deg F (4.5 - 21 deg C)) at time of installation, set joined members for 50 percent movement either way.

2. Adjust setting position of joined members proportionally for temperatures above 70 deg F (21 deg C).
3. Do not install sealant at temperatures below 40 deg F (4.5 deg C).
4. Refer to section on sealants elsewhere in Division 07 for handling and installation requirements for joint sealers.

3.05 CLEANING AND PROTECTION

A. Repair or replace work which is damaged or defaced, as directed by the Architect.

B. Remove from sheet metal surfaces any debris or substances which will inhibit uniform weathering.

C. Protect sheet metal work as recommended by the installer so that completed work will be clean, secured, and without damage at Completion.

END OF SECTION

SECTION 07 71 23 - GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Downspouts.

B. Downspout boots.

1.02 REFERENCES

A. ASTM B32 - Standard Specification for Solder Metal; 2020.

B. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2022.

C. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

A. Product Data:
   1. Provide data on prefabricated components.

B. Samples: Submit two samples, 6 inch (150 mm) long illustrating finish.

C. Shop Drawings: Indicate configurations, jointing methods, fastening methods, and installation details. Provide a plan drawing indicating type and location of joints.

1.04 DELIVERY, STORAGE, AND PROTECTION

A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope to drain.

B. Prevent contact with materials that could cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Copper: ASTM B370, cold rolled; natural finish.
   1. Thickness: 20 oz. (569 g).

B. Solder: ASTM B32; Sn50 (50/50) type.

C. Fasteners:
   1. Copper, brass.

2.02 ACCESSORIES

A. Downspout Boots: Cast iron.
   1. Manufacturer: _____.Product _____

2.03 FABRICATION

A. Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance.

B. Built-in Gutter Liners:
   1. Fabricate gutter liner sections from expansion joint to expansion joint (or end to end) using one piece of metal without transverse joints, unless otherwise approved.
   2. Where transverse joints are required (such as corners without expansion joints) and approved, employ riveted and soldered lap joints. Ensure that sheet is properly prepared to bright metal, and tinned. Form a 1-1/2 inch (38 mm)-wide lap; provide 1 row of tinner's rivets 1/2 inch (13 mm) from edge; pre-punch holes spaced at 2 inches (50 mm)on center; provide a second row of rivets 1/2 inch (13 mm) from opposite edge of lap, staggered with first row. Peen rivets securely against washers. Solder a fully-sweated, water-tight lap.

C. Downspouts:

1. Shop-fabricated hangers, SMACNA (ASMM) profile as indicated on the drawings.
2. SMACNA (ASMM) Fig. 1-31, rectangular profile.
3. Shop-fabricated hangers, SMACNA (ASMM) profile as indicated on the drawings.
4. Size: Match existing size.
5. Form bends and offsets as required by project conditions.
6. Crimp and form slip-joints in downspouts, and secure with mechanical fasteners.
7. Tin edges of copper/stainless sheet to be soldered. Solder metal joints weathertight. After soldering, remove flux. Wipe and wash solder joints clean.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that surfaces are ready to receive work.

C. Verify adequate slope to drain.

3.02 INSTALLATION

A. Install in accordance with SMACNA (ASMM) instructions.

B. Connect downspouts to downspout boots.

C. Connect downspout boots to storm sewer system in accordance with requirements in plumbing specifications.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section Includes:
   1. Sealants and joint backing.

B. Work of this section includes:
   1. Sealing of joints indicated in the schedule at the end of this section and in other locations required by the Contract Document.
   2. Seal joints in exterior envelope to prevent the entry or escape of water or air.
   3. Seal joints on the interior of the building to prevent the passage of water or air from space to space or between adjacent building materials and assemblies.
   4. Joints of a nature similar to that of joints indicated shall be sealed with same sealer, whether or not specifically indicated on the drawings and schedules to be sealed.

1.02 REFERENCES

A. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

1.03 DEFINITIONS

A. M Type Substrates: Cast-in-place concrete, concrete masonry units, clay brick, masonry mortar, natural stone.

B. G Type Substrates: Glass and transparent plastic glazing sheets.

C. A Type Substrates: Metals, porcelain, glazed tile, and smooth plastics.

D. O Type Substrates: Wood, unglazed tile; substrates not included under other categories.

E. Use T: Surfaces bearing pedestrian or vehicular traffic.

F. Use NT: Non-traffic-bearing surfaces.

1.04 SUBMITTALS

A. Product Data:
   1. Provide manufacturer's data on each joint sealer indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, color availability, and installation instructions.
   2. Provide manufacturer's technical guide containing recommendations for primers for each exterior sealant/substrate combination.

B. Samples: Submit two cured samples for each product exposed to view, illustrating full range of sealant colors available for selection.

C. Test Reports:
   1. Field installation test reports for each joint sealer.

D. Installer's Preconstruction Inspection Report: List all conditions detrimental to performance of joint sealer work.

E. Warranty.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original containers or bundles with labels showing manufacturer, product name or designation, color, shelf life, and installation instructions.

1.06 PROJECT SITE CONDITIONS

A. Environmental Limitations: Do not install sealers if any of the following conditions exist:
   1. Air or substrate temperature exceeds the range recommended by sealer manufacturer or is below 40 deg F (4.5 deg C) or is above 100 deg F (38 deg C).

2. Substrate is wet, damp, or covered with snow, ice, or frost.
3. Substrate is dusty, oily, or otherwise contaminated.

B. Dimensional Limitations: Do not install sealers if joint dimensions are less than or greater than that recommended by sealer manufacturer; notify the Architect and get joint sealer manufacturer's recommendations for alternative procedures.

C. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 WARRANTY

A. Submit a written warranty signed by the Contractor guaranteeing to correct failures in joint sealer work within a five year period after Date of Final Acceptance, without reducing or otherwise limiting any other rights to correction which the Owner may have under the contract documents. Failure is defined as failure to remain weathertight due to faulty materials or workmanship. Correction is limited to replacement of sealers.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

2.02 SEALANTS

A. High Movement Silicone Sealant: One- or two-part, non-acid-curing, ASTM C920, Grade NS, Class 25, Use NT, plus movement capability of 50 percent in extension, 50 percent in compression.
   1. Products:
      a. Dow; Dowsil 756SMS, 790, or 795: www.dow.com (60 g/l), (26 g/l), (32 g/l)
      b. Momentive GE Silicones; SilPruf9000 NB, SCS2000 SilPruf Sealant, or SCS2700 SilPruf LM Sealant: www.siliconeforbuilding.com (37 g/l), (20 g/l), (27 g/l)
      c. Sika Corporation; Sikasil WS-290 or WS-295: usa.sika.com (29 g/l), (37 g/l)

B. Mildew-Resistant Silicone Sealant: One-part, ASTM C920, Type S, Grade NS, Class 25, Use NT, formulated with fungicide, for interior use on nonporous substrates.
   1. Products:
      a. Dow; Dowsil 786: www.dow.com (36 g/l)
      b. Momentive GE Silicones; SCS1700 Sanitary: www.siliconeforbuilding.com (20 g/l)
      c. Sika Corporation; Sikasil N-Plus: www.sika.com (37 g/l)

C. Butyl Sealant: ASTM C920, Grade NS, Class 12-1/2, Uses NT; single component, solvent release, non-skinning, nonsag.
   1. Products:
      a. de Van Sealant, Inc.; 275.12 Non-Skinning, Standing Seam Pumpable Butyl Caulk: www.devansealants.com.
      b. Edge Adhesives; Rubex Non-Skinning Butyl Sealant: www.edgeadhesives.com.
      c. Pecora Corporation; BA-98: www.pecora.com (53 g/l)

D. One-Part Nonsag Urethane Sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Products:
      a. Master Builders Solutions; MasterSeal NP 1: www.master-builders-solutions.com/en-us (35 g/l)
      b. Pecora Corporation; Dynatrol I-XL FTH: www.pecora.com (18 g/l)
      c. Sika Corporation; Sikaflex 1a: www.sika.com (47.6 g/l)

E. Interior Floor Joints:
   1. One-Part Pourable Urethane Sealant for Use T: ASTM C920, Type S, Grade P, Class 25, Use T.
      a. Products:
         1) Sika Corporation; Sikaflex 1c SL: www.usa.sika.com (40 g/l)
         2) Pecora Corporation; Urexpan NR-201: www.pecora.com (45 g/l)

3) Master Builders Solutions; MasterSeal SL 1: www.master-builders-solutions.com/en-us (29 g/l)

2. Multipart Pourable Urethane Sealant for Use T: ASTM C920, Type M, Grade P, Class 25, Use T.
   a. Products:
      1) Pecora Corporation; Urexpan NR-200: www.pecora.com (0 g/l)
      2) Sika Corporation; Sikaflex 2c SL: www.sika.com (29.48 g/l)
      3) Master Builders Solutions; MasterSeal SL 2: www.master-builders-solutions.com/en-us (64.4 g/l)
3. Nonsag Urethane Sealant for Use T: ASTM C920, Type S or M, Grade NS, Class 25, Use T.
   a. Products:
      1) Pecora Corporation; Dynatred: www.pecora.com (39 g/l)
      2) Master Builders Solutions; MasterSeal CR 125: www.master-builders-solutions.com/en-us (118g/l)
      3) Sika Corporation; Sikaflex 1a: www.sika.com (47.6 g/l)

2.03 ACCESSORIES

A. Primer for Silicone Sealants: Nonstaining type, as recommended by joint sealant manufacturer for specific substrates encountered on the project and as verified by testing.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; not damaging to substrates, and compatible with joint forming materials.

C. Backer Rods: Flexible, nonabsorbent, compressible polyethylene foam, either open cell or nongassing closed cell, unless otherwise restricted by sealant manufacturer; preformed to appropriate size and shape.

D. Bond-Breaker Tape: Self-adhesive, polyethylene or other plastic tape, unless otherwise restricted by sealant manufacturer; suitable for preventing sealant adhesion.

E. Masking Tape: Nonabsorbent, nonstaining.

F. Tooling Agents: Approved by sealant manufacturer; nonstaining to sealant and substrate.

2.04 SEALANT COLORS

A. The Architect will select sealant colors from manufacturer's full range of available colors for each respective sealant and adjacent substrate.

B. Obtain approval of mock-up color before ordering job quantities of sealant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine joints for characteristics that may affect sealer performance, including configuration and dimensions.

B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Cleaning: Just before starting sealer installation, clean out joints as follows:
   1. Remove loose materials and foreign matter which might impair adhesion of sealant including, but not limited to, dust, dirt, coatings, paint, oil, and grease.
   2. Dry out damp and wet substrates thoroughly.
   3. Clean A-type and G-type substrates by chemical or other methods that will not damage the substrate.
   4. Remove loose particles by brushing and by blowing with oil-free compressed air.
   5. Concrete: Remove laitance and form-release coatings.
   6. Use methods which will not leave residues that will impair adhesion.

B. Prime joint substrates where required by this specification, manufacturer's recommendations, or adhesion tests.

C. Masking Tape: Use masking tape to keep primers and sealers off of adjacent surfaces which would be damaged by contact or by cleanup. Remove tape at the end of each day.

D. Protect elements surrounding the work of this section from damage or disfigurement.

E. Install fillers where needed to provide proper joint depth or support for sealant backers.

F. Do not begin joint sealer work until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

B. Comply with sealer manufacturer's installation instructions and recommendations, except where more restrictive requirements are specified.

C. Gunnable and Pourable Sealants: Comply with recommendations of ASTM C1193.

D. Backers:
   1. Install backers at depth required to result in shape and depth of installed sealant which allows the most joint movement without failure.
      a. Make backers continuous, without gaps, tears, or punctures.
      b. Do not stretch or twist backers.
   2. Use bond-breaker tape wherever it is necessary to keep sealant from adhering to back or third side of joint.
   3. If backers become wet or damp before installation of sealant, dry out thoroughly before proceeding.

E. Shape and Depth: Use methods recommended by manufacturer; completely fill the joint; make full contact with bond surfaces; tool nonsag sealants to smooth surface eliminating air pockets.
   1. Use concave joint shape shown in Figure 8 in ASTM C1193, where not otherwise indicated.
   2. Depth of sealant at center of joint, unless otherwise required by the Contract Documents or recommended by manufacturer:
      a. For joints up to 1/4 inch (6 mm) wide: Depth equal to width.
      b. For joints 1/4 to 1/2 inch (6 to 13 mm) wide: Depth equal to 1/4 inch (6 mm).
      c. For joints over 1/2 inch (13 mm) wide: Depth equal to 1/2 inch (13 mm) the width but not deeper than 1/2 inch (13 mm).
   3. Contact depth: Twice the depth of sealant at center of joint, unless otherwise required.

3.04 CLEANING

A. Clean adjacent soiled surfaces adjacent to joints as work progresses and before sealants set using methods and materials approved by manufacturers of sealers and of surfaces to be cleaned.

3.05 PROTECTION OF FINISHED WORK

A. Protect sealants from contamination and damage until cured.

B. Remove and replace damaged sealers.

3.06 FIELD INSTALLATION TESTS:

A. Before installation, install samples and test the adhesion of each type of sealers to each type of actual substrates. Do initial field adhesion hand-pull tests in the presence of the sealant manufacturer's representative. Report results.

B. Field Tests on Installed Sealants: Perform periodic tests for each combination of exterior sealer and substrate.
   1. Perform tests at a rate of ten tests for the first 1,000 feet (305 m). Thereafter, for each type of sealant being installed on each substrate perform one test per 2,500 sq.ft (232

sq.m) thereafter, or one test per floor per elevation, whichever is greater. Record the test results in a field adhesion test log.

C. For each type of sealant, obtain specific test procedure and pass/fail criteria from sealant manufacturer.

D. Field Test as described in ASTM C1193 Appendix X1.1 - Method A, Field-Applied Sealant Joint Hand Pull Tab:
   1. Seal at least 5 feet (1.5 m) lengths of joints and cure properly.
   2. Perform each test at the job site after the sealant is fully cured.
   3. Make a knife cut horizontally from one side of the joint to the other.
   4. Make two vertical cuts, from the horizontal cut, approximately 3 inches (76 mm) long, at both sides of the joint.
   5. Place a 1 inch (25 mm) mark on the sealant tab.
   6. Grasp the 2 inches (50 mm) piece of sealant firmly just beyond the 1 inch (25 mm) mark and pull at a 90 degree angle.
   7. If dissimilar substrates are being sealed, check the adhesion of sealant to each substrate separately. This is accomplished by extending the vertical cut along one side of the joint, checking adhesion to the opposite side, and then repeating for the other side.
   8. Pass criteria: When extended to its rated value, sealant remains intact or sealant tears in cohesion. Fail criteria: Before or at extension to its rated value, sealant releases from either substrate.
   9. Inspect the joints for complete fill. The joints should not have voids, and joint dimensions indicated.
   10. Repair the sealant pulled from the test area by applying new sealant to the test area. Care should be taken to ensure that the original sealant surfaces are clean and that the new sealant is in contact with the original sealant.

E. Report results.

3.07 SCHEDULE

A. General:
   1. Seal joints where indicated in exterior envelope to prevent the entry or escape of water or air.
   2. Seal joints on the interior of the building to prevent the passage of water or air from space to space or between adjacent building materials and assemblies.
   3. Joints of a nature similar to that of joints indicated shall be sealed with same sealer, whether specifically indicated on the drawings and schedules to be sealed or not.

B. Typical Exterior Joints:
   1. Including, but not limited to:
      a. Wall joints.
      b. Joints around perimeter of frames.
      c. Masonry joints with shelf angles.
      d. Exterior joints for which no other sealer is indicated.
   2. Use high movement silicone sealant unless otherwise indicated.

C. Exterior Door Thresholds: Set thresholds in butyl sealant.

D. Typical Interior Joints:
   1. Including, but not limited to:
      a. Between walls or partitions and adjacent casework, laboratory furniture, fixed shelving, fixed equipment, lighting fixtures, laboratory piped utility fittings.
      b. Between concrete or masonry or other material and the perimeters of frames of doors, windows, access panels, etc. (Note: Sealing of gypsum panel/metal stud construction is specified in Section 09 21 16 - Gypsum Board Assemblies.)
      c. Between hollow metal jambs and resilient flooring.
      d. Between concrete or masonry walls or partitions and adjacent columns, pilasters, walls, partitions, floors, ceilings, or other construction.

e. Interior joints for which no other sealer is indicated.

2. Use the following sealant:
   a. One part, nonsag urethane sealant.

E. Joints in Interior Wet Areas:
   1. Including, but not limited to:
      a. Toilet rooms.
      b. Breakrooms.
      c. Between walls or other surfaces and adjacent plumbing fixtures, fittings, and casework.
   2. Use the following sealants:
      a. Mildew-resistant silicone sealant.

F. Joints in Floor or Wall Tile:
   1. Including locations specified in Section 09 30 00 - Tiling.
   2. Use urethane sealant, Use T for floor joints, Use NT for wall joints.
   3. Backer: Backer rod.
   4. Joint shape: Flush joint configuration.
   5. Color: Match adjacent grout color, unless otherwise indicated.

END OF SECTION

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work Included in this Section:
   1. Steel Frames:
      a. Non-fire-resistance rated interior steel frames.
      b. Non-fire-resistance rated exterior steel frames.
      c. Fire-resistance rated interior steel frames.
      d. Steel frames in gypsum board partitions.
      e. Steel frames for glazed lights, interior transoms, and panels.

1.02 REFERENCES

A. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.

1.03 SUBMITTALS

A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.

B. Shop Drawings: Details of each opening showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

2.02 GENERAL

A. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door.
   2. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gauge
   3. Finish: Factory primed, for field finishing.

B. Exterior Door Frames: Full profile / continuously welded type.
   1. Weatherstripping: Separate, see Door Hardware section.

C. Interior Door Frames, Non-Fire-Rated:
   1. Gypsum board partitions. Knock-down type.

D. Interior Door Frames, Fire-Rated:
   1. Gypsum board partitions. Knock-down type.
   2. Fire Rating: Same as door, labeled.

E. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.04 ACCESSORY MATERIALS

A. Glazing:
   1. As specified in Section 08 80 00 - Glazing.

B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.05 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard.

B. Coordinate frame anchor placement with wall construction.

C. Coordinate installation of hardware.

D. Coordinate installation of glazing.

3.03 ERECTION TOLERANCES

A. Maximum Diagonal Distortion: 1/16 in (1.5 mm) measured with straight edge, corner to corner.

3.04 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Solid core veneer-faced doors with a transparent finish.
   2. Factory finishing.
   3. Prefitting by manufacturer.
   4. Premachining by manufacturer.

1.02 REFERENCES

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; 2021, with Errata.

1.03 SUBMITTALS

A. Product Data: Submit detailed technical information for each distinct product specified in this section. Include complete data for factory finished doors.

B. Shop Drawings: Prepare and submit shop drawings showing relevant information, including:
   1. Construction details for each distinct product type.
   2. Dimensions and location of blocking for hardware.
   3. Factory finishing details.

C. Samples: Submit samples for the following:
   1. Veneer verification samples: Minimum 8-1/2 x 11 inches (216 x 280 mm).
   2. Factory finishes:
      a. Verification samples: Minimum 8 inches (200 mm)-square sample for each color, effect, and type of factory finish.

D. Certificates:
   1. Submit certification that manufacturer's construction standards and tested fire door assembly requirements comply with contract requirements indicated for doors, hardware, hardware templating, size of lights, and other design characteristics.
      a. Clearly note any exceptions to certification, citing door number and hardware set. Exceptions shall be subject to the approval of the Architect.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as required to prevent damage or deterioration. Conform to manufacturer's recommendations, requirements of referenced standard, and recommendations of WDMA I.S. 1A, Appendix, "How to Store, Handle, Finish, Install, and Maintain Wood Doors."

B. Clearly label each door with opening number where door will be installed. Use removable, temporary labels or mark on door surface which will be concealed from view after installation.
   1. Coordinate door identification with shop drawing designations.

C. Environmental Requirements: Do not deliver, store, or install products of this section before building's design temperature and humidity levels have been achieved and will be maintained at those levels.

1.05 WARRANTIES

A. Manufacturer's Warranty (Interior Doors):
   1. Submit a written warranty signed by the manufacturer guaranteeing to correct failures in products which occur within the warranty period indicated below, without reducing or otherwise limiting any other rights to correction which the Owner may have under the contract documents. Failures are defined to include:
      a. Faulty workmanship.

b. Delamination.
c. Stile, rail, or core show-through (telegraphing) visible to the naked eye to any degree when viewed from a horizontal distance of 3 to 4 feet (0.9 to 1.2 m).
d. Warp (including bow, cup, and twist) in excess of 1/4 inch (6 mm) when measured in accordance with WDMA I.S. 1A.

2. Correction includes repair or replacement at the option of the Architect. Correct failures which occur within the following warranty periods after Final Completion:
a. Solid core interior doors: Life of original installation.

B. If, for any reason, the Contractor's work results in nullification of manufacturer's warranty, the Contractor shall correct failures and pay for such correction.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 WOOD DOORS - GENERAL REQUIREMENTS

A. Flush Doors: Conform to one of the following:
1. WDMA I.S. 1A: "Industry Standard for Interior Architectural Wood Flush Doors".
2. AWI/AWMAC/WI (AWS) "Architectural Woodwork Standards".

B. Door Performance Grade: Heavy Duty.

2.03 CONSTRUCTION

A. Appearance Grade: Premium.

B. Appearance Grade: Custom.

C. Faces:
1. Veneer species, cut, and grade for transparent finish (HPVA standards):
a. HPVA Grade AA.
b. HPVA Grade A.
c. White (sap) Maple, Plain Sliced.
2. Veneer matching for transparent finish:
a. Within panel face: Running match.

D. Construction: PC-5 (5-ply).

E. Core, Non-Fire-Rated Doors: Particleboard, bonded to stiles and rails, sanded.

F. Core, Fire Rated Doors: As specified above.

G. Door Thickness: 1-3/4 inch (44 mm) unless indicated otherwise.

H. Glue: Type I.

2.04 FABRICATION

A. General:
1. Fabricate to provide consistent clearances as indicated.
2. Hinge and lock edges:
a. Provide 1/8 inch (3 mm) standard bevel at edges, unless standard bevel would not precisely match hardware bevel; provide proper bevel for hardware.
3. Make neat mortises and cutouts for door hardware indicated.
4. Prefitting: Fabricate and trim doors to size at factory to coordinate with frame shop drawings and floor finishes as indicated in the finish schedule.
a. Provide non-standard clearances and tolerances indicated in Part 3.
5. Premachining: Make all mortises and cutouts required for hardware at the factory to conform to approved hardware schedule, hardware templates, and door frame shop drawings.

2.05 FACTORY FINISHING

A. Comply with one of the following:
   1. AWI/AWMAC/WI (AWS) Section 5, "Factory Finishing".
   2. WDMA I.S. 1A "Finishing".

B. Transparent Finish:
   1. WDMA I.S. 1A System TR-6 Catalyzed Polyurethane or TR-8 UV Cured Acrylated Polyester/Urethane.
   2. AWI/AWMAC/WI (AWS)AWI System 11 Catalyzed Polyurethane or System 9 UV Cured Acrylated Polyester/Urethane.
   3. Sheen: Satin.
   4. Staining: Match the Architect's sample.
   5. Grade: Premium.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect door frames and doors before beginning door installation.
   1. Verify that frames are properly installed and aligned and are capable of providing trouble free support for doors throughout range of door swing.

B. Correct unsatisfactory conditions before installing products of this section. Commencement of installation indicates acceptance of conditions.

3.02 INSTALLATION

A. Hardware Installation: Elsewhere in Division 08.

B. Install doors in accordance with manufacturer's recommended procedures and requirements of referenced standard.

C. Prefit Doors: Minimize field fitting to those procedures which are necessary to complete work unfinished during factory prefitting and to provide trouble free operation.
   1. Accurately align and fit doors for trouble free operation throughout range of door swing.

D. Prefitting Clearances:
   1. Door edge and head: 1/8 inch (3 mm).
   2. Door edge and jamb: 1/8 inch (3 mm).
   3. Door bottom edge and top surface of threshold: 1/4 inch (6 mm).
   4. Door bottom edge and floor covering surface or finish (where threshold is not indicated): 1/8 inch (3 mm).
   5. Meeting edges at pairs of doors: 1/8 inch (3 mm) total.

E. Installation Clearances: Install doors so as to maintain prefitting clearances specified.

F. Factory-Finished Doors: Before installing doors, restore finish at door edges cut during field fitting.

3.03 ADJUSTING

A. Adjust doors for proper operation; coordinate with hardware adjustment; replace doors that cannot be properly adjusted.

B. Where door finishes are damaged during installation, restore in a manner that results in the door showing no evidence of the restoration. If refinished door cannot be made to match other doors, remove refinished door and replace with new conforming work at the Contractor's expense.

C. Protect installed work.

END OF SECTION

SECTION 08 14 33 - STILE AND RAIL WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wood doors, stile and rail design; fire rated and non-fire rated.

B. Panels of wood and glass.

1.02 RELATED REQUIREMENTS

A. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

C. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.

1.04 SUBMITTALS

A. Product Data: Indicate stile and rail core materials and construction; veneer species, type and characteristics.

B. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, and cutouts for glazing.

C. Samples: Submit two samples of door veneer, 6 by 6 inches (___ by ___ mm) in size illustrating wood grain, stain color, and sheen.

D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

E. Installer's qualification statement.

F. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

B. Quality Certification:

1. Provide labels or certificates indicating that installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
2. Provide designated labels on shop drawings as required by certification program.
3. Provide designated labels on installed products as required by certification program.
4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package, deliver, and store doors in accordance with quality standard specified.

B. Accept doors on site in manufacturer's packaging, and inspect for damage.

C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, telegraphing core construction, and _____.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Stile and Rail Wood Doors:
   1. Karona, Inc; ____: www.karonadoor.com/#sle.
   2. Masonite Architectural; Aspiro Authentic Stile & Rail Doors: www.architectural.masonite.com/#sle.
   3. VT Industries, Inc; ____: www.vtindustries.com/#sle.

2.03 DOORS

A. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.

B. Exterior Doors: 1-3/4 inches (44.45 mm) thick unless otherwise indicated; solid lumber construction; mortise and tenon joints; water repellent treated. Transparent finish as indicated on drawings.

C. Interior Doors: 1-3/4 inches (44.45 mm) thick; solid lumber construction; mortise and tenon joints. Transparent finish as indicated on drawings.
   1. Basis of Design: TS Series; TruStile, www.trustile.com, (877) 283-4511

2.04 DOOR AND PANEL FACINGS

A. Veneer Facing for Transparent Finish: White Oak, HPVA Grade A, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

B. Adhesive: Type I - Waterproof.

2.05 DOOR CONSTRUCTION

A. Panels: Flat.

B. At exterior doors, provide aluminum flashing at the top and bottom rail for full thickness and width of door.

C. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.

D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

E. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

F. Cut and configure exterior door edge to receive recessed weatherstripping devices. Provide edge clearances in accordance with referenced quality standards.

G. Fire Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.06 FINISHES

A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
   1. Transparent:
      a. System - 1, Lacquer, Nitrocellulose.
      b. Stain: As selected by Architect.
      c. Sheen: Flat.

2.07 ACCESSORIES

A. Glazing: See Section 08 80 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standards.
   1. Install fire-rated doors in accordance with NFPA 80 requirements.
B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
C. Machine cut for hardware.
D. Coordinate installation of doors with installation of frames and hardware.

END OF SECTION

SECTION 08 51 13 - ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Alternate A1: Extruded aluminum windows with fixed sash.

B. Factory glazing.

C. Base Bid: Interior aluminum storm windows.

1.02 REFERENCE STANDARDS

A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights; 2017.

B. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

C. AAMA 502 - Voluntary Specification for Field Testing of Newly Installed Fenestration Products; 2021.

D. AAMA 612 - Voluntary Specification, Performance Requirements, and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum; 2020, with Errata (2022).

E. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

H. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).

I. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

A. Product Data: Include component dimensions, information on glass and glazing, internal drainage details, and descriptions of hardware and accessories.

B. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, anchorage locations, weatherproofing details, and installation requirements.

C. Samples:
   1. Framing: Two samples, 12 by 12 inch (300 by 300 mm) in size illustrating typical corner construction, accessories, and finishes.

D. Grade Substantiation: Prior to submitting shop drawings or starting fabrication, submit one of the following showing compliance with specified grade:
   1. Evidence of AAMA Certification.
   2. Evidence of WDMA Certification.
   3. Evidence of CSA Certification.
   4. Test report(s) by independent testing agency itemizing compliance and acceptable to authorities having jurisdiction.

E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

F. Specimen warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of AAMA CW-10.

B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).

B. Maintain this minimum temperature during and 24 hours after installation of sealants.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Correct defective work within a five year period after Date of Final Acceptance.

C. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 BASIS OF DESIGN - AW PERFORMANCE CLASS WINDOWS

A. Grade: AAMA/WDMA/CSA 101/I.S.2/A440 having Performance Class of AW, and Performance Grade at least as high as specified design pressure.

B. Glazing: As specified

C. Fixed, Thermally-Broken:

2.03 ALUMINUM WINDOWS

A. Aluminum Windows: Extruded aluminum frame and sash, factory fabricated, factory finished, with operating hardware, related flashings, and anchorage and attachment devices.
   1. Movement: Accommodate movement between window and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.

B. Fixed, Non-Operable Type:
   1. Construction: Thermally broken.
   2. Glazing: Double; clear; transparent.

C. Aluminum Storm Windows: Extruded aluminum frame and sash, factory fabricated, factory finished, with operating hardware and anchorage and attachment devices.
   1. General: Provide units that fit within existing exterior window openings. Allow for out-of-square and irregular conditions.
   2. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
   3. Thermal Movement of Exterior Units: Design to accommodate thermal movement caused by 180 degrees F (82.2 degrees C) surface temperature without buckling stress on glass, joint seal failure, damaging loads on structural elements, damaging loads on fasteners, reduction in performance, or other detrimental effects.

4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for operating hardware and imposed loads.
   a. Assembly: Removable panels in master frame.
      1) Materials:
         (a) Aluminum: ASTM B221 or ASTM B221M 6063 alloy, temper as applicable to extrusion shape.
      2) Fasteners: Zinc plated, cadmium plated, or other noncorrosive metal compatible with aluminum.
      3) Finish: Manufacturer's standard color range, powder-coated finish complying with AAMA 2604.
5. Glazing: Provide factory-glazed units.
   a. Glass Type: Annealed float glass.
      1) Thickness: 1/8 inch (3 mm).
      2) Emissivity: Less than 0.16.
   b. Glazing Gaskets: Removable and reusable virgin vinyl glazing splines producing tightly mitered corners.
   c. Alternate A-4: Provide low-e coating on exterior-facing side of glass.
      1) Products:
         (a) VNE1-63, by Viracon.
         (b) Guardian SNX-62/27, by Guardian certified fabricator.
         (c) Vitro Solarban 70XL, by Vitro certified fabricator.

2.04 COMPONENTS

A. Sills: ____ inch (____ mm) thick, extruded aluminum; sloped for positive wash; fit under sash leg to 1/2 inch (12 mm) beyond wall face; one piece full width of opening; jamb angles to terminate sill end. Provide end dams.

B. Fasteners: Stainless steel.

C. Glazing Materials: See Section 08 80 00.

D. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

2.05 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

2.06 FINISHES

A. High Performance Organic Coatings: AAMA 2604; multiple-coat, thermally-cured fluoropolymer system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall openings are ready to receive aluminum windows.

3.02 PRIME WINDOW INSTALLATION

A. Install windows in accordance with manufacturer's instructions.

B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.

D. Install sill and sill end angles.

E. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Install glass and infill panels in accordance with requirements; see Section 08 80 00.

3.03 STORM WINDOW INSTALLATION

A. Install windows in accordance with manufacturer's instructions.

B. Attach storm window frame to perimeter of prime window opening; accommodate construction tolerances and other irregularities.

C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.

3.04 FIELD QUALITY CONTROL

A. Provide services of aluminum window manufacturer's field representative to observe for proper installation of system and submit report.

B. Provide field testing of installed aluminum windows by independent laboratory in accordance with AAMA 502 and AAMA/WDMA/CSA 101/I.S.2/A440 during construction process and before installation of interior finishes.

1. Conduct tests on individual windows prior to 5 percent per floor completion of this work.
2. Field test for water penetration in accordance with ASTM E1105 using Procedure B - cyclic static air pressure difference; test pressure shall not be less than 1.9 psf (91 Pa).
3. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf (75 Pa).

C. Repair or replace fenestration components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust hardware for smooth operation and secure weathertight closure.

3.06 CLEANING

A. Remove protective material from factory finished aluminum surfaces.

B. Wash surfaces by method recommended and acceptable to window manufacturer; rinse and wipe surfaces clean.

END OF SECTION

SECTION 08 59 00 - METAL WINDOW RESTORATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Repair and restoration of existing steel windows. Frames to be restored in-situ. Sash to be restored in shop. Work shall generally include:
   1. Paint removal.
   2. Cleaning and repair of metal.
   3. Removal and replacement of glazing compound.
   4. Repair and restoration of hardware.
   5. Refinishing.

B. Hazardous Materials: The existing glazing compound is known to contain asbestos and the existing paint is known to contain lead.
   1. A copy of the Hazardous Materials Abatement report is available in the Project Manual.
   2. Contractor remains solely responsible for complying with all applicable regulations.

1.02 REFERENCES

A. ASCE 7-05 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers; 2006.

B. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2009.

C. SWI - Steel Windows and Doors; Steel Window Institute; current edition.

D. Standards for the Rehabilitation of Historic Structures; United States Secretary of the Interior.

1.03 SUBMITTALS

A. Product Data: Written product information which demonstrates materials to be used on the project comply with contract documents.

B. Quality Control Submittals - Restoration Program
   1. Work Description: Prior to the Work, the Contractor shall submit a written description of applications and procedures proposed. Include methods of application, equipment, dilution of chemicals, temperature, and repetitive procedures.
   2. Protection: Prior to the Work, the Contractor shall submit a written description of proposed methods and materials for preventing damage to adjacent building materials.

C. Trade contractor qualifications.
   1. Trade contractor must have demonstrated proficiency in the restoration of historic properties by the successful performance of work of the nature specified on at least three historic properties in the last ten years, the foregoing installations having been the complete and undivided responsibility of the trade contractor and the work of the foreman proposed for this project. Submit the following:
      a. Name of Foreman and Certificate of Training.
      b. Name, location and description of the three representative projects.
      c. Name and phone number of Owner, Architect and Contractor references for each of the three representative projects.

1.04 QUALITY ASSURANCE

A. The general objective of this Section is to preserve and protect the original materials whenever possible. Loose components are to be reinstalled in their original position. New replacement materials are to match in size, color, texture, materials, and finish the original materials.

B. Applications that cause damage to historic materials will not be used. Chemical and physical applications shall be undertaken using the gentlest means possible first. More invasive treatments are to be done only when approved by the Architect.

C. It is the objective of this Section that any replacement window components are indistinguishable from the original work. When questionable situations are encountered in the field, notify the Architect immediately for direction.

D. Trade contractor: Work must be performed by a firm having not less than 5 years successful experience in comparable window restoration projects and employing personnel skilled in the restoration process and operations indicated.

E. Mock-up:
   1. Perform mock-up at one window, including both in-situ restoration of frame and shop restoration of sash.
   2. Mock-up shall include all restoration, finish, and installation required by the contract documents.
   3. Mock-up shall include all repair to window hardware to achieve a smoothly operating condition.
   4. Mock-up will be used to determine the feasibility of installing weatherstripping.
   5. Commence work on mock-up only after approval of all submittals.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Deliver and store products and materials in manufacturer's sealed packages. Protect materials from damage and store in dry locations.

B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.06 PROJECT CONDITIONS

A. Administer applications in compliance with manufacturer's recommendations for their products.

B. Protect surrounding surfaces of the building from injury resulting from the work.

C. Protect adjacent building materials from coming into contact with mechanical, abrasive or chemical means that could cause damage.

D. Dispose daily of empty containers, waste, and by-products of the work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify wall openings and adjoining materials are ready to receive work of this section.

B. Prior to commencement of work, examine surfaces scheduled to be treated.
   1. Report any unsatisfactory conditions in writing.
   2. Do not apply products to unsatisfactory substrates.

3.02 PREPARATION

A. Coordinate and furnish anchorages and setting drawings, diagrams, templates, instructions, and directions for the installation of items having integral anchors embedded in concrete or masonry. Coordinate delivery of such items to the project site.

3.03 WINDOW FRAME RESTORATION

A. Window frames to be restored in-situ. Remove window sash prior to beginning frame restoration.

B. Remove loose paint, blast clean and remove surface rust using a wire brush to meet standard preparation for high performance coatings.

C. If required to achieve a stable substrate for new paint coating and to allow for complete window operability, remove paint using chemical paint remover. Fully remove paint remover, if used to accept new paint.

D. Remove perimeter sealant.

E. Recoat window frames. See Specification Section 09 9600 High Performance Coatings.

F. Install backing materials and perimeter sealant. See Specification Section 07 9200. Allow perimeter sealant to cure for two weeks before painting.

3.04 WINDOW SASH RESTORATION

A. Remove window sash for shop restoration.

B. Remove glazing compound. Salvage glass for reinstallation. Replace damaged glass to match existing.

C. Remove loose paint and surface rust using scrapers and a wire brush.

D. If required to achieve a stable substrate for new paint coating and to allow for complete window operability, remove paint using chemical paint remover. Fully remove paint remover, if used, to accept new paint.

E. Re-Glazing:

1. Install glazing in glazing compound, ensuring that glazing is fully back-bedded in a thin coating of compound.
2. Tool exterior compound to form a neat, uniform triangle that aligns with the interior surface of the muntins.
3. Install sealant to dry, clean surfaces at ambient temperatures above 60 deg. F and below 90 deg. F.

F. Recoat window sash. See Specification Section 09 9600 High Performance Coatings.

3.05 WINDOW OPERATION

A. It is not the intent of this project to return the windows to an operable condition.

B. Install weatherstripping, if determined feasible through the mock-up process.

3.06 ERECTION TOLERANCES

A. Maximum Variation from Level or Plumb: 1/16 inches in 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m).

3.07 ADJUSTING

A. Adjust hardware for secure weathertight closure.

3.08 CLEANING

A. Remove protective material from shop finished surfaces.

B. Remove labels and visible markings.

C. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.

D. Remove excess sealant by method acceptable to sealant manufacturer.

3.09 PROTECTION

A. Do not permit continuing construction activities near unprotected finish surfaces.

END OF SECTION

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section “Alternates” for alternates affecting this section.
2. Division 06 Section “Rough Carpentry”
3. Division 06 Section "Finish Carpentry”
4. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:

    a. “Metal Doors and Frames”
    b. “Flush Wood Doors”
    c. “Stile and Rail Wood Doors”
    d. “Interior Aluminum Doors and Frames”
    e. "Aluminum-Framed Entrances and Storefronts"
    f. “Special Function Doors”
    g. "Entrances”

6. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.
7. Division 26 “Electrical” sections for connections to electrical power system and for low-voltage wiring.
8. Division 28 “Electronic Safety and Security” sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL, LLC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:

   a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.
   b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
   c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:

   a. Wiring Diagrams: For power, signal, and control wiring and including:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.

3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.

a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

4. Door Hardware Schedule:

a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
c. Indicate complete designations of each item required for each opening, include:
   1) Door Index: door number, heading number, and Architect's hardware set number.
   2) Quantity, type, style, function, size, and finish of each hardware item.
   3) Name and manufacturer of each item.
   4) Fastenings and other pertinent information.
   5) Location of each hardware set cross-referenced to indications on Drawings.
   6) Explanation of all abbreviations, symbols, and codes contained in schedule.
   7) Mounting locations for hardware.
   8) Door and frame sizes and materials.
   9) Degree of door swing and handing.
   10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

5. Key Schedule:

a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:

a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:

    a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    b. Catalog pages for each product.
    c. Final approved hardware schedule edited to reflect conditions as installed.
    d. Final keying schedule
    e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
    f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:

    a. fire door assemblies, in compliance with NFPA 80.
    b. required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:

    a. For door hardware: DHI certified AHC or DHC.
    b. Can provide installation and technical data to Architect and other related subcontractors.
    c. Can inspect and verify components are in working order upon completion of installation.
    d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.

4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:

    a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.

b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

2. Electrified Door Hardware

a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

3. Accessibility Requirements:

a. Comply with governing accessibility regulations cited in “REFERENCES” article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference

a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2) Preliminary key system schematic diagram.
3) Requirements for key control system.
4) Requirements for access control.
5) Address for delivery of keys.

2. Pre-installation Conference

a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Inspect and discuss preparatory work performed by other trades.
c. Inspect and discuss electrical roughing-in for electrified door hardware.
d. Review sequence of operation for each type of electrified door hardware.
e. Review required testing, inspecting, and certifying procedures.
f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:

a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer’s original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

1.06 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

D. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.

1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer’s published listings.

a. Mechanical Warranty
   1) Locks
      a) 3 years
   2) Exit Devices
      a) 3 years
   3) Closers
      a) 30 years
   4) Automatic Operators
      a) 2 years

b. Electrical Warranty
   1) Locks
      a) 1 year
   2) Exit Devices
      a) 1 year

1.08 MAINTENANCE

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.

C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer’s recognized installation standards for application intended.
2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with “Metal Doors and Frames”, “Flush Wood Doors”, “Stile and Rail Wood Doors” to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
2. Use materials which match materials of adjacent modified areas.
3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

D. Cable and Connectors:

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Ives 5BB series

2. Acceptable Manufacturers and Products:

a. McKinney TB series (Owner Preferred)
b. Stanley FBB series

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five-knuckle, ball bearing hinges.
3. Provide hinge weights and sizes as specified in hardware sets.
4. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
6. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

a. Steel Hinges: Steel pins
b. Non-Ferrous Hinges: Stainless steel pins
c. Out-Swinging Exterior Doors: Non-removable pins
d. Out-Swinging Interior Lockable Doors: Non-removable pins
e. Interior Non-lockable Doors: Non-rising pins

7. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer and Product:

a. Von Duprin EPT-10

2. Acceptable Manufacturers and Products:

a. ABH PT1000
b. Security Door Controls PTM

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.05 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. DCI

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.06 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Schlage L9000 series

2. Acceptable Manufacturers and Products:

a. Sargent 8200 series
b. Corbin-Russwin ML2000 series

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.

4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches. Provide motor based electrified locksets that comply with the following requirements:

    a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
    b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case
    c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
    d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
    e. Connections – provide quick-connect Molex system standard.

8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.

    a. Lever Design: 03A.

2.07 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

    a. Von Duprin 99/33A series

2. Acceptable Manufacturers and Products:

    a. Detex Advantex series
    b. Precision APEX 2000 series

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to “KEYING” article, herein.
3. Provide grooved touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer’s approved strikes.

9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder dogging as specified at non fire-rated openings.
12. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
13. Provide electrified options as scheduled.
14. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
15. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.08 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Schlage Primus (no substitution)

B. Requirements:

1. Provide cylinders/cores compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset; manufacturer’s series as indicated. Refer to “KEYING” article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.

a. Conventional Patented Restricted: cylinder with Full Size Interchangeable Core (FSIC) with patented, restricted keyway.

3. Patent Protection: Cylinders/cores requiring use of restricted, patented keys, patent protected through the year 2029.
4. Nickel silver bottom pins.

2.09 KEYING

A. Scheduled System:

1. Existing factory registered system:

a. Keying by the UNC Access Control Shop. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:

a. Replaceable Construction Cores.
1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
a) 3 construction control keys

b) 12 construction change (day) keys.
2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:

a. Provide Full Size Interchangeable Core (FSIC) #1-bitted cylinders/cores for keying by the UNC Access Control Shop. Forward keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
b. Provide keys with the following features:
1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
2) Patent Protection: Keys and blanks protected by one or more utility patent(s).

c. Identification:
1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
2) Identification stamping provisions must be approved by the Architect and Owner.
3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

d. Quantity: Furnish in the following quantities.
1) Change (Day) Keys: 3 per cylinder/core.
2) Permanent Control Keys: 3.
3) Master Keys: 6.

2.10 ELECTRIC STRIKES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

a. Von Duprin 6000 series

2. Acceptable Manufacturers and Products:

a. Folger Adam 300 series
b. HES 1006 series

B. Requirements:

1. Provide electric strikes designed for use with type of locks shown at each opening.
2. Provide electric strikes UL Listed as burglary resistant that are tested to a minimum endurance test of 1,000,000 cycles.
3. Where required, provide electric strikes UL Listed for fire doors and frames.
4. Provide transformers and rectifiers for each strike as required. Verify voltage with electrical contractor.

2.11 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. LCN 4040XP series

2. Acceptable Manufacturers and Products:

   a. Corbin-Russwin DC8000 series
   b. Sargent 281 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2 inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

   a. LCN 4600 series

2. Acceptable Manufacturers and Products:

   a. Precision D4990 series
   b. Besam Power Swing

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI/BHMA A156.19.
2. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to minus 30 degrees F.
3. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door
4. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
5. Provide drop plates, brackets, and adapters for arms as required for details.
6. Provide hard-wired actuator switches and receivers for operation as specified.
7. Provide weather-resistant actuators at exterior applications.
8. Provide key switches with LED's, recommended and approved by manufacturer of automatic operator as required for function described in operation description of hardware group below. Cylinders: Refer to "KEYING" article, herein.
9. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
10. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.13 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.14 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. Trimco

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Provide protection plates with countersunk screw holes.
3. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
4. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.15 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:

a. Glynn-Johnson

2. Acceptable Manufacturers:

a. Rixson
b. ABH

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.16 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Trimco
b. Burns

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
2. Where a wall stop cannot be used, provide overhead stop.
3. Where wall or overhead stop cannot be used, provide floor stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.17 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:

    a. Zero International

2. Acceptable Manufacturers:

    a. National Guard
    b. Reese

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.18 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:

    a. Ives

2. Acceptable Manufacturers:

    a. Steelcraft
    b. Republic

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.19 MAGNETIC HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:

    a. LCN

2. Acceptable Manufacturers:

    a. ABH
    b. Rixson

B. Requirements:

1. Provide wall or floor mounted electromagnetic door release as specified with minimum of 25 pounds of holding force. Coordinate projection of holder and armature with other hardware and wall conditions to ensure that door sits parallel to wall when fully open. Connect magnetic holders on fire-rated doors into the fire control panel for fail-safe operation.

2.20 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:

a. Schlage

2. Acceptable Manufacturers:

a. GE-Interlogix
b. Sentrol

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.21 LATCH PROTECTORS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. Trimco

B. Provide stainless steel latch protectors of type required to function with specified lock.

2.22 COAT HOOKS

A. Manufacturers:

1. Scheduled Manufacturer:

a. Ives

2. Acceptable Manufacturers:

a. Burns
b. Trimco

B. Provide coat hooks as specified.

2.23 FINISHES

A. Finish: Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.

C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Where on-site modification of doors and frames is required:

1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
2. Field modify and prepare existing doors and frames for new hardware being installed.
3. When modifications are exposed to view, use concealed fasteners, when possible.
4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:

    a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
    b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
    c. Doors in rated assemblies: NFPA 80 for restrictions on on-site door hardware preparation.

3.03 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
4. Installation Guide for Doors and Hardware: DHI TDH-007-20

B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

I. Lock Cylinders:

1. Install construction cores to secure building and areas during construction period.
2. Replace construction cores with permanent cores as indicated in keying section.
3. Furnish permanent cores to Owner for installation.

J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:

1. Conduit, junction boxes and wire pulls.
2. Connections to and from power supplies to electrified hardware.
3. Connections to fire/smoke alarm system and smoke evacuation system.
4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
5. Connections to panel interface modules, controllers, and gateways.
6. Testing and labeling wires with Architect's opening number.

K. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

L. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

M. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

N. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

O. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

P. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

Q. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
2. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.05 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items per manufacturer’s instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.06 DOOR HARDWARE SCHEDULE

A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier’s responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

HARDWARE GROUP NO. 01

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 02

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	369AA36" (914MM)	AA	ZER

HARDWARE GROUP NO. 03

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	369AA36" (914MM)	AA	ZER

HARDWARE GROUP NO. 04

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CORRIDOR LOCK	L9456T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 05

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CLASSROOM LOCK	L9070T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	90S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 06

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	90S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 07

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 08

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	90S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 09

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HARDWARE GROUP NO. 10

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CORRIDOR LOCK	L9456T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	100S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 11

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIV W/DB COIN TURN	L9444 03A L583-363 XL11-422	626	SCH
1	EA	ELECTRIC STRIKE	6216 FSE DSLC CON 12/16/24/28 VAC/VDC	630	VON
1	EA	SURF. AUTO OPERATOR	4631 CS WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	BLK	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	SINGLE HOOK	507B	626	IVE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1			POWER SUPPLY BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND UNLOCKED. ACCESS MANUALLY BY OPERATING OUTSIDE LEVER, OR AUTOMATICALLY BY WAVE ACTUATOR WHICH RELEASES ELECTRIC STRIKE AND OPENS DOOR. OPERATING INSIDE THUMBTURN LOCKS OUTSIDE LEVER AND THROWS DEADBOLT, RENDERING OPERATOR INACTIVE. EGRESS BY OPERATING INSIDE LEVER, WHICH RETRACTS LATCHBOLT AND DEADBOLT, ALLOWING DOOR TO BE OPENED MANUALLY, OR AUTOMATICALLY BY WAVE ACTUATOR.

HARDWARE GROUP NO. 12

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIV W/DB COIN TURN	L9444 03A L583-363 XL11-422	626	SCH
1	EA	ELECTRIC STRIKE	6216 FSE DSLC CON 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	SINGLE HOOK	507B	626	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1			CARD READER BY OTHERS		
1			POWER SUPPLY BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND UNLOCKED. ACCESS MANUALLY BY OPERATING OUTSIDE LEVER, OR AUTOMATICALLY BY WAVE ACTUATOR WHICH RELEASES ELECTRIC STRIKE AND OPENS DOOR. OPERATING INSIDE THUMBTURN LOCKS OUTSIDE LEVER AND THROWS DEADBOLT, RENDERING OPERATOR INACTIVE. EGRESS BY OPERATING INSIDE LEVER, WHICH RETRACTS LATCHBOLT AND DEADBOLT, ALLOWING DOOR TO BE OPENED MANUALLY, OR AUTOMATICALLY BY WAVE ACTUATOR.

HARDWARE GROUP NO. 13

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIV W/DB COIN TURN	L9444 03A L583-363 XL11-422	626	SCH
1	EA	ELECTRIC STRIKE	6216 FSE DSLC CON 12/16/24/28 VAC/VDC	630	VON
1	EA	OH STOP	90S	630	GLY
1	EA	SURF. AUTO OPERATOR	4631 CS WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	BLK	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	SINGLE HOOK	507B	626	IVE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1			POWER SUPPLY BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND UNLOCKED. ACCESS MANUALLY BY OPERATING OUTSIDE LEVER, OR AUTOMATICALLY BY WAVE ACTUATOR WHICH RELEASES ELECTRIC STRIKE AND OPENS DOOR. OPERATING INSIDE THUMBTURN LOCKS OUTSIDE LEVER AND THROWS DEADBOLT, RENDERING OPERATOR INACTIVE. EGRESS BY OPERATING INSIDE LEVER, WHICH RETRACTS LATCHBOLT AND DEADBOLT, ALLOWING DOOR TO BE OPENED MANUALLY, OR AUTOMATICALLY BY WAVE ACTUATOR.

HARDWARE GROUP NO. 14

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB457 12"	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
2	EA	OH STOP	450H	630	GLY
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 15

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CORRIDOR LOCK	L9456T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 16

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CORRIDOR LOCK	L9456T 03A 09-544	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 17

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Operational Description: Door normally closed and locked. Access by key from outside. Inside lever always free for egress.

HARDWARE GROUP NO. 18

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HARDWARE GROUP NO. 19

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 20

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 21

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR BOTTOM	369AA36" (914MM)	AA	ZER

HARDWARE GROUP NO. 22

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	L9080T 03A	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	LOCK GUARD	LG1	630	IVE
1	EA	OH STOP & HOLDER	90H	630	GLY
1	EA	RAIN DRIP	142AA	AA	ZER
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

HARDWARE GROUP NO. 23

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	CDSI-99-NL	626	VON
1	EA	MORTISE CYL TURN	09-900 114 XB11-720 36-083	626	SCH
1	EA	PRIMUS RIM CYLINDER	20-757-XP	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 24

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	CDSI-99-NL	626	VON
1	EA	MORTISE CYL TURN	09-900 114 XB11-720 36-083	626	SCH
1	EA	PRIMUS RIM CYLINDER	20-757-XP	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 25

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	PANIC HARDWARE	LD-99-NL	626	VON
1	EA	PRIMUS RIM CYLINDER	20-757-XP	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE GROUP NO. 26

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9927-L-BE-F-LBR-03-499F	626	VON
2	EA	SURFACE CLOSER	4111 EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	FIRE/LIFE WALL MAG	SEM7850 AS REQ (12/24/120V AC/DC TRI-VOLT)	689	LCN
2	SET	MEETING STILE	328AA-S	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER

DOORS ON HOLD-OPENS. CONNECTION TO FIRE ALARM BY OTHERS.

HARDWARE GROUP NO. 27

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	FIRE EXIT HARDWARE	9927-L-BE-F-LBR-03-499F	626	VON
2	EA	SURFACE CLOSER	4111 CUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	SET	MEETING STILE	328AA-S	AA	ZER
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 28

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	ELEC PANIC HARDWARE	SD-RX-LC-QEL-99-EO-CON 24 VDC	626	VON
1	EA	ELEC PANIC HARDWARE	SD-RX-LC-QEL-99-NL-OP-110MD-CON 24 VDC	626	VON
1	EA	PRIMUS RIM CYLINDER	20-757-XP	626	SCH
3	EA	PRIMUS MORT. CYL.	20-763 36-083	626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
2	EA	OH STOP	100S	630	GLY
2	EA	SURFACE CLOSER	4111 EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	SET	GASKETING	429AA-S	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
2	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT CARD READER BY OTHERS		SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN. IMMEDIATE EGRESS ALWAYS ALLOWED BY DEPRESSING EXIT DEVICE PUSH RAIL, WHICH SHUNTS DOOR POSITION SWITCH (REX) AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PUSHED OPEN.

HARDWARE GROUP NO. 29

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
8	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	ELEC PANIC HARDWARE	SD-RX-LC-QEL-99-EO-CON 24 VDC	626	VON
1	EA	ELEC PANIC HARDWARE	SD-RX-LC-QEL-99-NL-OP-110MD-CON 24 VDC	626	VON
1	EA	PRIMUS RIM CYLINDER	20-757-XP	626	SCH
3	EA	PRIMUS MORT. CYL.	20-763 36-083	626	SCH
2	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
2	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	BLK	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142AA	AA	ZER
1	SET	GASKETING	429AA-S	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT CARD READER BY OTHERS		SCE

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN. IMMEDIATE EGRESS ALWAYS ALLOWED BY DEPRESSING EXIT DEVICE PUSH RAIL, WHICH SHUNTS DOOR POSITION SWITCH (REX) AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PUSHED OPEN.

HARDWARE GROUP NO. 30

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092TEU 03A RX CON 12/24 VDC	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
1			POWER SUPPLY BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 31

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 CON TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092TEU 03A RX CON 12/24 VDC	626	SCH
1	EA	PRIMUS CORE	20-740-XP	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
1			POWER SUPPLY BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 32

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURF. AUTO OPERATOR	4631 CS WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	BLK	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND UNLOCKED. PUSH/PULL OPERATION, EITHER MANUALLY, OR AUTOMATICALLY BY WALL-MOUNTED WAVE ACTUATOR.

HARDWARE GROUP NO. 33

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	OH STOP	90S	630	GLY
1	EA	SURF. AUTO OPERATOR	4631 CS WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813	BLK	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND UNLOCKED. PUSH/PULL OPERATION, EITHER MANUALLY, OR AUTOMATICALLY BY WALL-MOUNTED WAVE ACTUATOR.

HARDWARE GROUP NO. 34

Provide each CO door(s) with the following:

QTY	DESCRIPTION	CATALOG NUMBER	FINISH	MFR

CASED OPENING - NO HARDWARE REQUIRED.

END OF SECTION

SECTION 08 80 00 - GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clear Tempered Glass.

B. Insulating Clear Glass with Low-E Coating.

C. Fire Rated Glass.

D. Fire Rated and Impact Safety Rated Glass.

E. Laminated Glass.

F. Structural Silicone Glazing.

1.02 REFERENCES

A. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).

B. ASTM C1036 - Standard Specification for Flat Glass; 2021.

C. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.

D. GANA (GM) - GANA Glazing Manual; 2008.

E. GANA (SM) - GANA Sealant Manual; 2008.

F. ASTM E 773 - Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units; 2001.

G. ASTM E 774 - Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units; 1997.

1.03 SUBMITTALS

A. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

B. Samples: Submit two samples 12 x 12 inches (305 x 305 mm) in size of glass and plastic units, showing coloration and design.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with GANA (GM) and GANA (SM) for glazing installation methods.

1.05 WARRANTY

A. Provide a ten year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.

PART 2 PRODUCTS

2.01 FLAT GLASS MATERIALS

A. Clear Float Glass (08 80 00.CF): Clear, annealed.
   1. Comply with ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
   2. Comply with ASTM C1048. Provide Type HS (heat strengthened) glass except where Type FT (fully tempered) is required.

B. Tempered Safety Glass (08 80 00.TS): Clear; fully tempered with horizontal tempering.
   1. Comply with ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select) and ASTM C1048.
   2. Comply with ANSI Z97.1.

C. Laminated Acoustical Glass (08 80 00.LA):

1. STC: 35.
2. Total Unit Thickness: 1/4 inch (6 mm) nominal.
    a. 1/8 inch (3 mm) clear float glass.
    b. 0.030 inch (0.76 mm) PVB interlayer.
    c. 1/8 inch (3 mm) clear float glass.

2.02 FIRE RATED GLAZING PRODUCTS

A. Fire Rated Glass: (08 80 00.F): Monolithic Ceramic Glazing Material.
    1. Fire Rating: 20 minutes to 90 minutes.
    2. Thickness: 3/16 inch (5 mm) overall.
    3. Products:
        a. FireLite Premium by Nippon Electric Glass Co., distributed by Technical Glass Products.
        b. Pyran Platinum; Schott North America, Inc.
        c. SGG Keralite Select, by Vetrotech Saint Gobain North America.

2.03 SEALED INSULATING GLASS MATERIALS

A. General Requirements:
    1. Comply with ASTM E 774 and E 773, Class CBA.
    2. Purge interpane space with dry hermetic air.

B. Clear Insulating Low-E Glass Units (08 80 00.ICE): Double pane with glass to elastomer edge seal.
    1. Outer pane of clear glass, inner pane of clear glass.
    2. Low-E Coating: Place low-e coating on No. 2 surface within the unit.
    3. Maximum Summer U-Value of unit: 0.27.
    4. Maximum Winter U-Value of unit: 0.29.
    5. Maximum SHGC of 0.29.
    6. Minimum Visible Light Transmittance: 62%.
    7. Maximum Reflectivity, exterior: 12%.
    8. Maximum Reflectivity, interior: 13%
    9. Total unit thickness of 1 inch (25 mm) minimum.
    10. Provide tempered units where indicated on drawings.
    11. Products:
        a. VNE1-63, by Viracon.
        b. Guardian SNX-62/27, by Guardian certified fabricator.
        c. Vitro Solarban 70XL, by Vitro certified fabricator.

2.04 ACCESSORIES

A. Decorative Plastic Glazing Film (08 80 00.GF1): Vinyl type, meets ASTM E84, Class A.
    1. Application: Location as indicated on drawings.
    2. Series Type: Frosted
    3. Thickness Without Liner: 0.169 inch (4.3 mil).
    4. Width: 60 inch (1524mm).
    5. Visible Light Transmittance (VLT): 73% percent, nominal.
    6. Diffuse Visible Light Reflectance, Exterior: 6% percent, nominal.
    7. UV transmission: 4%
    8. Solar Heat Absorbance: 17%
    9. Manufacturers:
        a. BASIS OF DESIGN: Decorative Films, LLC; https://www.decorativefilm.com/
            1) Product: Solyx SX-3160 Shimera (Exterior Film)
        b. Other acceptable manufacturers:
            1) Avery Dennison Graphics Solutions, www.graphics.averydennison.com.
            2) 3M Graphics Solutions, solutions.3m.com/wps/portal/3M/en_US/Graphics/3Mgraphics.

B. Substitutions: See Section 01 60 00 Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 INSTALLATION

A. Install glazing in accordance with GANA (GM) and system manufacturer's instructions.

3.03 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after Work is complete.

C. Clean glass and adjacent surfaces.

END OF SECTION

SECTION 08 91 00 - LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers, frames, and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 62 00 - Sheet Metal Flashing and Trim.

B. Section 23 31 00 - HVAC Ducts and Casings: Ductwork attachment to louvers.

1.03 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012 (Reapproved 2015).

C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2021.

D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

1.04 SUBMITTALS

A. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.

C. Test Reports: Independent agency reports showing compliance with specified performance criteria.

1.05 WARRANTY

A. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS

A. Louvers:
   1. Airline Louvers: www.airlinelouvers.com/#sle.
   2. Construction Specialties, Inc: www.c-sgroup.com/#sle.
   3. Ruskin Company: www.ruskin.com/#sle.

2.03 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf (1.2 kPa) without damage or permanent deformation.
   2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft (3.1 g/sq m) water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.

3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
4. Screens: Provide bird screens at every louver.

B. Stationary Louvers: Horizontal blade, extruded aluminum construction.
1. Free Area: 50 percent, minimum.
2. Blades: Drainable.
3. Frame: 4 inches (100 mm) deep, channel profile; corner joints mitered and, with continuous recessed caulking channel each side.
4. Aluminum Thickness: Frame 12 gauge, 0.0808 inch (2.05 mm) minimum; blades 12 gauge, 0.0808 inch (2.05 mm) minimum.
5. Aluminum Finish: Superior performing organic coatings; finished after fabrication.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), ____ alloy, ____ temper.

2.05 FINISHES

A. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch (0.030 mm).

B. Color: Custom, to match approved sample.

2.06 ACCESSORIES

A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.

B. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.

C. Bird Screen: Interwoven wire mesh of steel, 14 gauge, 0.0641 inch (1.63 mm) diameter wire, 1/2 inch (13 mm) open weave, diagonal design.

D. Fasteners and Anchors: Stainless steel.

E. Head and Sill Flashings: See Section 07 62 00.

F. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.

B. Coordinate with installation of flashings by others.

C. Install louvers level and plumb.

D. Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

E. Secure louver frames in openings with concealed fasteners.

F. Coordinate with installation of mechanical ductwork.

3.03 CLEANING

A. Strip protective finish coverings.

B. Clean surfaces and components.

END OF SECTION

SECTION 09 05 10 - CEILING COORDINATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Coordination of ceiling system installation with work of other sections, including those listed below.

1.02 SUBMITTALS

A. Coordination Drawings: Submit reflected ceiling plans showing correlation between work of this section and work of other sections.
   1. Minimum drawing scale: 1/8 inch equals 1 foot.

B. Show the following:
   1. Ceiling suspension elements.
   2. Hanger type and method of attachment to structure.
   3. Joints in ceilings.
   4. Light fixtures.
   5. HVAC equipment.
   6. Fire suppression system components.
   7. Equipment and valves requiring access panels.
   8. Access panels in ceilings.
   9. Access panels in walls.
   10. Other items within ceilings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. Make adjustments in the location of such elements as directed by the Architect, without change in contract time or price.

B. Prepare and distribute to affected installers, data necessary for coordination with related work.

C. Do not begin construction of any of these elements prior to such coordination.

END OF SECTION

SECTION 09 06 10 - PARTITION SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Partitions faced with gypsum panels, and including facings of:
   1. Gypsum wallboard.
   2. Glass mat faced gypsum backing board.
   3. Gypsum board shaft wall with any of the above facings.

B. Metal furring faced with gypsum panels.

1.02 DEFINITIONS

A. Partitions: Every partition dividing two spaces is a noise, air, and dust control partition.

PART 2 PRODUCTS

2.01 GYPSUM PANEL FACINGS

A. Provide types of gypsum panels in locations listed below.

B. General use, and where not otherwise indicated:
   1. Provide gypsum wallboard.

C. Where tile is indicated:
   1. Provide glass mat faced gypsum backing board.

2.02 PRODUCTS

A. Provide products specified elsewhere in Division 09.

PART 3 EXECUTION

3.01 GENERAL

A. Construct partitions in accordance with requirements specified elsewhere in Division 09.

B. Seal smoke, noise, air, and dust partitions in accordance with requirements specified in Gypsum Board Assemblies section and Joint Sealers section.

3.02 PARTITION LEGEND

A. On the drawings, partition types are indicated using tags composed generally as follows (see individual descriptions in partition schedule below for specific requirements).

B. First Position: Fire rating.
   1. Zero, 1, 2, 3, or 4 hours.

C. Second Position: Construction Material. Extend all partitions and materials from floor to overhead solid structure unless otherwise indicated.
   1. A — Metal studs and gypsum panels from floor to 6 inches (150 mm) above ceiling.
   2. C — Chase wall.
   3. CH — Shaft wall (using CH studs typical.)
   4. D — Divider, partial height.
   5. F — Furring: Hat-shaped channels.
   6. SA — Metal studs to structure, gypsum panels from floor to 6 inches (150 mm) above ceiling.
   7. S — Metal studs and gypsum panels.
   8. U — Steel studs and gypsum board from floor to underside of ceiling.
   9. Z — Furring: Z-shaped channels.

D. Third Position: Indicates construction features as described under individual descriptions in partition schedule below.

E. Fourth Position:
   1. G Gypsum panels (wallboard, tile backer, veneer base, etc.); type of panel as specified above under "gypsum panel facings".

F. Final Position, outside of box on drawings:
   1. Dimension of stud or masonry measured to outside face. Dimensions of stud are actual. Dimensions of masonry are actual unless indicated otherwise.
   2. Where no stud dimension is indicated adjacent to box, provide 3-5/8 inches (92 mm) studs.
   3. Where no dimension is indicated adjacent to box for shaftwall framing, provide 4 inches (100 mm) framing.

3.03 PARTITION SCHEDULE

0 C 59 G:
No fire rating.
Construct metal stud, gypsum panel partition per UL Des. U436, except do not install bracing between parallel rows of studs.
Install mineral fiber batts in stud cavities both sides.

0 D 2 G:
Partial height room divider.
No fire rating.
Metal studs from floor to height indicated.
Gypsum panels both sides, with gypsum return at head and jambs unless otherwise indicated.

0 F 1 G:
No fire rating.
Metal furring channels, 1 layer gypsum panels.

0 S 1 G:
No fire rating.
Metal studs to structure.
Gypsum panels 1 side only.

0 S 49 G:
No fire rating.
Construct metal stud, gypsum panel partition per UL Des. U465.
Install mineral fiber batts in stud cavities. No resilient channels.

0 SA 1 G:
No fire rating.
Metal studs to structure.
Gypsum panels 1 side only; extend from floor to 6 inches (150 mm) above ceiling.

1 CH 40 G:
1 hr. fire rating; construct shaftwall per UL Des. U415E.
No batts.

1 S 40 G:
1 hr. fire rating; construct metal stud, gypsum panel partition per UL Des. U465.
No batts.
No resilient channels.

1 S 49 G:
1 hr. fire rating; construct metal stud, gypsum panel partition per UL Des. U465.
Install mineral fiber batts in stud cavities. No resilient channels.

2 S 48 G:
2 hr. fire rating; construct metal stud, gypsum panel partition per UL Des. U411.

No batts.

2 S 56 G:

2 hr. fire rating; construct metal stud, gypsum panel partition per UL Des. U411. Install mineral fiber batts in stud cavities.

END OF SECTION

SECTION 09 21 00 - PLASTER REPAIR AND CONSERVATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Retain as much existing plaster as possible at locations where existing plaster is to remain exposed. Plaster to be retained and repaired includes wall and ceiling plaster in stairwells, hallways, offices and classrooms, and wall plaster in other areas. Refer to drawings for additional information. Repair plaster is to be formulated to match existing plaster in composition and finish texture. Existing plaster is sand finished. Compositional testing of the plaster is included in the scope of work. The Contract Documents specify a quantity for each type of repair to be included in the Contract Price. Unit Prices are required for each type of repair as indicated in Section 01 22 00 Unit Prices.

1.02 SUMMARY

A. General:
   1. The conservation of the existing plaster is a primary objective in this work, where walls and ceilings are existing to remain, and exposed to view. In all operations, exercise the utmost care to do no damage to these materials. If the Contractor believes that any specified procedure may damage these materials, notify the Architect prior to proceeding with the work.

B. Section includes:
   1. Flat plaster applied directly to masonry.
      a. Removal of existing finishes prior to plaster repair.
      b. Repair of existing plaster.
      c. Removal and replacement of damaged or deteriorated existing plaster.

1.03 REFERENCES

A. ASTM C 28-96 -- Standard Specification for Gypsum Plasters; 1996.

B. ASTM C 35-95 -- Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster; 1995.

C. ASTM C 206-97 -- Standard Specification for Finishing Hydrated Lime; 1984 (Reapproved 1997).

D. ASTM C 841-97 -- Standard Specification for Installation of Interior Lathing and Furring; 1997.

E. ASTM C 842-97a -- Standard Specification for Application of Interior Gypsum Plaster; 1985 (Reapproved 1997).

F. ASTM C 847-95 -- Standard Specification for Metal Lath; 1995.

G. ASTM C 59-95 -- Standard Specification for Gypsum Casting and Molding Plaster; 1995.

H. ASTM C 631-95a -- Standard Specification for Bonding Compounds for Interior Plastering; 1995

I. ML/SFA 920-91 -- Guide Specifications for Metal Lathing and Furring; 1991.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for systems specified, demonstrating compliance with requirements. Where more than one type or style of a particular product is shown on the same page, clearly identify the specific product being submitted.

B. Material Certificates: Submit producer's certification that each kind of bulk material, such as plaster sand, complies with specified requirements.

C. Installer Qualifications:

D. Plaster Analysis: Submit laboratory results of analysis of historic plaster.

E. Plaster Mix Design: Submit proposed mix design for each type of plaster specified.

1.05 QUALITY ASSURANCE

A. Installer: Firm with not less than 10 years of successful experience in plaster conservation work similar in scope to work of this project.
   1. Maintain throughout duration of the work a crew who is fully qualified to satisfy requirements of the specifications.
   2. Maintain throughout the duration of the work a qualified superintendent who has served in this role for the Trade Contractor on the projects submitted in the Contractor Pre-Qualification Affidavit.
   3. Contractor approved by the Architect, upon review of Contractor Pre-Qualification Affidavit.
   4. All work of this section shall be performed by a single firm.

B. Mock-ups: Construct mock-ups at locations approved by the Architect. Include typical edge details, and similar features. Approved mock-ups will establish the acceptable limits of variation in texture, pattern, color, and workmanship.
   1. Mock-up shall consist of the following:
      a. Mock-up of execution of each Method of Plaster Work specified. The mock-up area for each method shall be at least 3 linear feet, 9 square feet, or greater if required to fully execute the method.
   2. Acceptable mock-ups may be included in the work.
   3. Refer to Part 3, Methods of Plaster Work, T1 for mockup requirement for trenching repair option.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original and unopened packaging, with brand names and manufacturer's labels intact and legible.

B. Store materials in dry location, fully protected from weather and direct exposure to sunlight.

C. Handle cast plaster units in manner consistent with their shape and strength to prevent damage.

1.07 PROJECT CONDITIONS

A. Environmental Requirements: Comply with provisions of ASTM C 842 and recommendations of gypsum plaster manufacturer for gypsum plastering for environmental conditions before, during, and after application of plaster.
   1. Beginning at the start of the 1st coat application procedures and continuing until 14 days following completion of the final coat, the plaster trade contractor shall take humidity readings twice daily.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Natural Hydraulic Lime Plaster
   1. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
      a. US Heritage.
      b. St. Astier.
      c. LaFarge.

B. Gypsum Plaster:
   1. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
      a. Gold Bond Building Products, a National Gypsum Division.
      b. USG Corporation.
      c. GenLime.

2.02 GYPSUM PLASTER MATERIALS

A. Natural Hydraulic Lime Plaster

1. Some of the existing plaster in this project is a single system fibred lime and cement plaster. The specific replacement plaster shall also be a single system fibred plaster.

B. Gypsum Plaster:
   1. Base Coat Materials:
      a. Gypsum neat plaster, fibered: ASTM C 28.
      b. Sand: ASTM C35, for base coat plaster.
   2. Finish Coat Plaster Materials:
      a. Gypsum gaging plaster: ASTM C 28.
      b. Finishing hydrated lime: ASTM C 206, Type S.
      c. Gypsum molding plaster: ASTM 59.
      d. Sand: To match size and gradation of sand in existing sanded finish.

2.03 MISCELLANEOUS MATERIALS

A. General: Provide miscellaneous materials as produced or recommended by plaster manufacturer.

B. Bonding compounds and surface hardeners:
   1. Provide products complying with requirements of the contract documents and made by one of the following:
      a. Larsen Products Corp.
   2. Surface Applied Bonding Compound; Polyvinyl Acetate Homopolymer; Weld Crete by Larsen Products Corp.
   3. Surface Hardener; Acrylic Admix 101 by Larsen Products Corp.

2.04 PLASTER MIXES

A. General: Measure proportions accurately by volume. Use of shovels for measuring is not allowed. Mix plaster using mechanical mixers unless hand mixing is specifically approved by the Architect.

B. Plaster: Comply with ASTM C206 and C207 for proportions for each substrate and finish type required. Mixes shall be formulated to match existing plaster as determined by plaster analysis. Mixes specified below are approximate and will be finalized based upon the results of the plaster analysis and the mock up process.
   1. NHL Plaster: Two-coat work over masonry with sanded finish:
      a. Base coat: NHL, fibered, with pre-mixed sand aggregate.
         1) 1 part NHL to 2-1/2 parts sand.
         2) Fiber per manufacturer's recommendations.
      b. Finish coat: NHL with pre-mised sand and aggregate.
         1) 1 part NHL to 2-1/2 parts sand. Mix shall be adjusted if required to match texture of adjacent existing finish plaster.

C. Gypsum Plaster: Comply with ASTM C 842 for proportions for each substrate and finish type required. Mixes shall be formulated to match existing plaster as determined by plaster analysis. Mixes specified below are approximate and will be finalized based upon the results of the plaster analysis and the mock up process.
   1. System 1: Three-coat work over masonry with sanded finish:
      a. Scratch coat: Gypsum neat plaster, fibered with job-mixed sand aggregate;
         1) At masonry substrates: 1 part gypsum, 3 to 3-1/2 parts sand.
      b. Brown coat: Gypsum neat plaster, fibered with job-mixed sand aggregate;
         1) At masonry substrates: 1 part gypsum, 3 to 3-1/2 parts sand.
      c. Finish coat: Gypsum gaging plaster; 1 part plaster, 3-1/2 parts lime; sand as required to match existing sanded finish.
   2. System 2: Gypsum Molding Plaster. For repair of minor chips and cracks.
      a. Gypsum Gaging Plaster: 1/2 part gaging plaster, 1/2 part molding plaster, 1 part lime; sand as required to match existing sanded finish.

PART 3 - EXECUTION

3.01 PLASTER ANALYSIS

A. Extract samples of existing mortar of each type of plaster to be repaired or replaced. Samples shall be approximately 3” by 3” square. The following tests shall be performed and the analysis shall include a report from the testing laboratory explaining the results and including the calculation of the mix proportions of each sample.ASTM C1324-10 Standard Test Method for Examination and Analysis
   1. Petrographic analysis.
   2. X-ray diffraction.
   3. Chemical composition.

B. Testing shall be performed by one of the following testing laboratories:
   1. Wiss Janney Elstner Associates, Inc., 330 Pfingsten Road, Northbrook, Illinois.
   2. Atkinson-Noland and Associates, 2619 Spruce Street, Boulder, Colorado.
   3. Building Conservation Associates, Inc. 329 Race Street, Philadelphia, Pennsylvania 19106.

3.02 METHODS OF PLASTER WORK

A. The following methods shall be used as specified in the Schedule of Plaster Work and/or as marked directly on the plaster during the Pre-construction Testing.
   1. R1. Crack Repair: Repair all cracks greater than hairline in width.
      a. Fill existing cracks with finish coat plaster.
         1) Slightly widen the crack with a sharp, pointed tool. Remove existing damaged plaster back to a point at which sound material is reached.
         2) Clean plaster surface adjacent to damaged area. Remove loose and foreign matter that could impair adhesion.
         3) Wet existing surface prior to placement of plaster.
         4) Fill all voids with plaster System 2, making infilled areas smooth and level with adjacent surfaces. Match surface texture of adjacent existing plaster.
   2. R2. Flat plaster: Selective removal and replacement of only the plaster finish coat within an area.
      a. Remove the finish coat which is debonded from the base coats. The rest of the finish coat is to remain. All of the base coat is to remain.
      b. Clean the surface. Remove loose and foreign matter that could impair adhesion.
      c. Scratch remaining plaster to increase key to new plaster.
      d. Apply a coat of surface hardener Admix A101 to the remaining plaster.
      e. Apply one coat of surface applied bonding compound over the hardened remaining surface and at the full perimeter of the area to be plastered on the edge of the adjacent plaster to remain.
      f. Install a new finish coat as described in gypsum plaster System 1. The surface of the new finish coat shall be flush with and shall match the texture of the adjacent existing plaster that remains.
   3. R3. Flat plaster: Selective removal and replacement of all coats of plaster.
      a. Sawcut the perimeter of the areas indicated to be removed.
      b. Remove plaster within the area bounded by the sawcut.
      c. At masonry substrates, rake out mortar joints in exposed brick masonry to improve key of new plaster.
      d. Apply bonding compound at the full perimeter of the area to be plastered on the edge of the adjacent plaster to remain and to the surface of the masonry substrate.
      e. Install gypsum plaster System 1. The surface of the new finish coat shall be flush with and shall match the texture of the adjacent existing plaster that remains.
   4. N1. Selective installation of new plaster at masonry substrates.
      a. Clean the surface. Remove loose and foreign matter that could impair adhesion.

b. Rake out mortar joints in exposed brick masonry to improve key of new plaster.
c. Apply a coat of surface hardener Admix A101 to the remaining plaster.
d. Apply bonding compound at the full perimeter of the area to be plastered on the edge of the adjacent plaster to remain and to the surface of the masonry substrate.
e. Install gypsum plaster System 1. The surface of the new finish coat shall be flush with and shall match the texture of the adjacent existing plaster that remains.

5. T1. Selective trenching or removal and replacement of plaster.
   a. Sawcut the perimeter of the areas indicated to be removed.
   b. Remove plaster within the area bounded by the sawcut. The removal shall be full depth to the substrate.
   c. Exercise care to not damage substrate or adjacent elements.
   d. Apply bonding compound at the full perimeter of the area to be plastered on the edge of the adjacent plaster to remain and to the surface of the masonry substrate.
   e. Install gypsum plaster System 1. The surface of the new finish coat shall be flush with and shall match the texture of the adjacent existing plaster that remains.
   f. Contractor option (pending mock-up approval): The finish coat for this work may be gypsum plaster System 2 without lime; i.e. ½ part gaging plaster and ½ part molding plaster to reduce the required drying time prior to painting. Prior to proceeding with this option, work at one trench location shall be completed using this mixture and then it shall be reviewed by the Architect. The Architect will review it for surface texture and shape which are both to match the adjacent existing surfaces. If the resulting product is approved, this option may be used for all similar trenching work.

3.03 SCHEDULE OF PLASTER WORK

A. Flat plaster where existing construction is three coat plaster system applied directly over brick masonry.
   1. Repair cracks as described in Method of Plaster Work, R1.
   2. Remove and replace finish coat plaster at all areas where finish coat only is unstable, as described in Methods of Plaster Work, R2.
   3. Remove and replace all plaster coats at areas where all coats are unstable, as described in Methods of Plaster Work, R3.
   4. Perform plaster trenching where indicated on the drawings, as described in Methods of Plaster Work, T1.
   5. Where items have been removed leaving no existing plaster, install new plaster as described in Methods of Plaster Work, N1.

3.04 PREPARATION

A. Protection: Coordinate work and provide protective coverings to protect adjacent surfaces from soiling and damage.
   1. Provide protection for adjacent materials during plaster removal activities.
   2. Provide water-resistant protection under and around mixers and water containers.
   3. Enclose mixing area to protect adjacent occupied areas from dust.
   4. Wash all containers and equipment outside, in an area designated by the Owner.

B. Cleaning: Clean all materials deleterious to plaster bond such as dust, dirt, and grease from the surfaces adjacent to the new plaster prior to installing new plaster.

C. Remove existing paint finishes back to bare plaster without damaging the plaster surface. Early paint layers are composed of calcimine and must be remove to allow for adhesion of new finishes.

D. Grounds and Screeds: Install temporary grounds and screeds as necessary to ensure accurate rodding of plaster to true surfaces, coordinate with scratch coat work.

3.05 ENVIRONMENTAL HEALTH AND SAFETY

A. The existing paint is known to contain lead. All applicable regulations must be followed in sanding, scraping or otherwise disturbing these materials including the removal of plaster with

paint attached and in the disposal of these materials. Initial testing has been conducted by S&ME. A copy of this report is included in section 00 30 00 Information Available to Bidders.

3.06 REMOVAL OF PLASTER

A. Remove areas of plaster as marked directly on the plaster during the Preconstruction Testing. Protect and do not damage adjacent plaster to remain. Repair any damage which occurs in accordance with the specified methods of repair for that element as described in the Schedule of Plaster Work.

B. Prior to removing plaster, the perimeter of the section to be removed shall be sawcut in order to preserve the adjacent work which is to remain. The sawcut shall extend completely through all coats of the plaster to the substrate.

C. Plaster shall be removed by chiseling from the side.

3.07 BONDING COMPOUND AND PLASTER HARDENER APPLICATION

A. Apply surface applied bonding compound uniformly, using roller and brush, to form a continuous film over the entire surface. Allow to dry as recommended by manufacturer. Exercise care to avoid applying bonding compound too far ahead of plaster application.

B. Prior to applying plaster, inspect bonding agent application to assure a continuous film over the entire bonding surface and to determine if coated surface has become contaminated from airborne dust, dirt, or other sources.

C. Apply surface applied bonding compound to the surface of the existing plaster at any location where new plaster will abut the existing plaster.
   1. At masonry substrates also apply surface applied bonding compound to the surface of the masonry substrate.

D. Surface hardener shall be applied to all existing surfaces of plaster to which bonding compound and new plaster will be applied.

3.08 PLASTER APPLICATION - GENERAL

A. General: Comply with gypsum plaster manufacturer's recommendations and provisions of ASTM C 842.
   1. Coordinate plaster application with installation of adjacent work to avoid soiling and damage of plaster and other work.

B. Tolerances:
   1. Deviation from plane not to exceed 1/8 inch in 10 feet as measured with a straightedge at any location on surface unless this requirement conflicts with meeting the requirement of the following paragraphs.
      a. New plaster application shall align with limits of the old plaster which has been removed. Note the visible evidence of limits of old plaster around the perimeter of each area and work the finish surface of the new plaster around the perimeter of each area to this mark. New plaster shall generally follow the contour of the existing plaster that was removed.

3.09 ADJUSTING

A. Corrections: Cut out and replace defective areas of new work so that repairs match acceptable work in all respects. Defective work includes, but is not limited to, areas showing cracks, dents, crazing, blisters, and other surface imperfections, as well as areas where bond to substrate has failed.

3.10 CLEANING

A. Removal: Remove and discard temporary protection after plaster work in each area has been completed. Carefully remove plaster from other exposed surfaces, leaving them in undamaged condition; dispose of packaging materials and plaster debris.

3.11 PROTECTION

A. Protect all existing materials from damage or soiling.

END OF SECTION

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior metal stud wall framing.
B. Interior metal shaftwall framing and bracing systems.
C. Resilient furring channels.
D. Acoustic insulation.
E. Gypsum wallboard.
F. Abuse-resistant gypsum wallboard.
G. Glass mat faced tile backing board.
H. Interior gypsum ceilings/soffits.
I. Joint treatment and accessories.
J. Aluminum Trim.

1.02 REFERENCES

A. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2020.
C. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
D. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.
E. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
F. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2019.
G. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
H. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
I. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2017.
J. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
K. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.
L. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
M. GA-600 - Fire Resistance and Sound Control Design Manual; 2021.
N. ITS (DIR) - Directory of Listed Products; Current Edition.
O. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's product data for systems required. Include installation instructions and data sufficient to show compliance with requirements.
B. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
C. Design Data:

1. Submit data substantiating gauge and spacing of metal framing members to comply with specified loading requirements.
2. Submit data substantiating bracing requirements.
3. Submittal of manufacturer's standard published load tables, marked to show products selected to comply with design requirements and project conditions, will be acceptable. Where manufacturer's standard published load tables are not adequate to demonstrate compliance with design requirements and project conditions, submit design data bearing the seal of a professional engineer licensed to practice in the state in which the project is located.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original and unopened packages, containers, or bundles, with brand names and manufacturer's labels intact and legible.

B. Store materials in dry location, fully protected from weather and direct exposure to sunlight.

C. Stack gypsum board products flat and level, properly supported to prevent sagging or damage to ends and edges.

D. Store corner bead and other metal and plastic accessories to prevent bending, sagging, distortion, or other mechanical damage.

1.05 PROJECT CONDITIONS

A. Do not store or install products until building is fully enclosed and temperature and humidity controlled.

B. Temperature: Maintain temperature in areas of installation between 50 to 80 deg F. (10 to 26.5 deg C.) for at least 48 hours before installation begins and continuously thereafter.

C. Ventilation: Provide controlled ventilation and dehumidification.

D. Do not allow excessive variations in humidity or temperature.

PART 2 PRODUCTS

2.01 METAL FRAMING MATERIALS

A. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel of size and properties necessary to comply with ASTM C754, for the spacing indicated.
   1. Studs: C-shaped .
      a. Nominal depths: As indicated in Section09 06 10 - Partition Schedule or as otherwise indicated on the drawings.
   2. Runners: U-shaped, sized to match studs.
      a. Nominal depths: As indicated in Section 09 06 10 - Partition Schedule or as otherwise indicated on the drawings.
   3. Ceiling Channels: C-shaped, cold-rolled.
   4. Furring:
      a. Hat-shaped, minimum depth of 7/8 inch (22 mm), except as otherwise indicated.
      b. Where indicated as "resilient" or "acoustical," or where required for STC ratings are indicated, provide manufacturer's special type designed for attachment by one flange for reduced sound transmission.
   5. Maximum deflection of shaftwall framing of L/240 at 7.5 psf (360 Pa).
   6. Maximum deflection of wall framing of L/240 at 5 psf (240 Pa).
      a. For wall framing to receive ceramic tile: L/360 at 5 psf (239 Pa).
   7. Thickness: Provide thickness as required for span, loading, deflection, and other required criteria.
      a. Minimum thickness, all locations, unless otherwise indicated: 0.019 inch (0.48 mm) design thickness / 0.018 inch (0.45 mm) minimum base metal thickness.

b. Minimum thickness, abuse resistant or impact resistant gypsum board locations: 0.031 inch (0.80 mm) design thickness / 0.03 inch (0.75 mm) minimum base metal thickness.
c. Minimum thickness, tile backer board locations: 0.031 inch (0.80 mm) design thickness / 0.03 inch (0.75 mm) minimum base metal thickness.
d. So-called "EQ" or "equivalent gauge" framing with thickness equal to or greater than specified above is acceptable. So-called "EQ" or "equivalent gauge" framing with thickness less than specified above is not acceptable.

8. Finish: G40 hot-dip galvanized per ASTM A653/A653M.
   a. So-called "G40e" equivalent coating is not acceptable.
9. Stud spacing: 16 inches (400 mm), maximum.
10. Shaftwall framing spacing: 24 inches (600 mm), maximum.
11. Furring spacing: 16 inches (400 mm) on center, maximum.

B. Establish bracing size and spacing for the following partitions. (See Section 09 06 10 - Partition Schedule):
   1. Type A.
   2. Type SA.
   3. Type U.
   4. Type F and Z when furring is installed over spaced supports.

C. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

D. Partition Head To Structure Connections:
   1. Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.
   2. Provide fire-rated design at fire-rated partitions listed by UL (DIR), ITS (DIR), or GA-600.

2.02 GYPSUM BOARD MATERIALS

A. Gypsum Wallboard: ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Edges: Tapered; beveled or rounded.
   2. Thickness: 5/8 inch (16 mm), all locations. 1/2 inch (13 mm) not acceptable.
   3. Type X: Fire resistant, UL or Intertek rated.
   4. Type C: Fire resistant, UL or Intertek rated.

B. Abuse-Resistant Gypsum Wallboard: ASTM C1396/C1396M. Gypsum wallboard especially formulated for resistance to surface damage. Gypsum fiber panels or wallboard with enhanced gypsum core and heavy duty face and back paper.
   1. Thickness: 5/8 inch (16 mm), Type X.
   2. Edges: Tapered.
   3. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M, (test sample may be primed and painted).
   4. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
   5. Soft Body Impact: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
   6. Products:
      a. Certainteed Extreme Abuse Resistant Gypsum Board with M2T.
      b. Georgia-Pacific: DensArmor Plus Abuse-Resistant Interior Panels.
      c. USG Corporation: Mold Tough AR.

C. Glass Mat Faced Gypsum Backing Board: ASTM C1178/C1178M.
   1. Core: Water-resistant silicone-treated gypsum core.
   2. Facers: Alkali-resistant fiberglass mat front and back. Front face surfaced with water and vapor barrier coating.
   3. Thickness: 5/8 inch (16 mm), Type X.
   4. Product:
      a. Georgia-Pacific Corporation: Dens-Shield Tile Backer Firestop Type X.

b. USG Durock Brand Glass-Mat Tile Backerboard Firecode Type X.
c. CertainTeed GlasRoc Diamondback Tile Backer Type X.

D. Gypsum Shaftwall or Coreboard: ASTM C1396/C1396M; sizes to minimize joints in place; 1 inch (25 mm) thick; square edges, ends square cut.

2.03 ACCESSORIES

A. Except as otherwise specifically indicated, provide trim and accessories by manufacturer of gypsum board materials, made of galvanized steel or zinc alloy and configured for concealment in joint compound.
1. Include corner beads, edge trim, and other trim units necessary for project conditions. Provide accessories as required in order to achieve details indicated, whether or not specific accessories are shown on the drawings.
2. Exposed trim: At locations indicated, provide manufacturer's standard metal units designed to be left exposed or semi-exposed.

B. Corner Beads: Galvanized steel.

C. Edge Trim: Bead types as detailed.

D. Control Joints: At locations indicated, provide manufacturer's standard one-piece control joints of zinc alloy.

E. Aluminum Trim: Extruded Aluminum alloy 6063-T5, pre-punched for screw attachment, formed to receive gypsum compound.
1. Finish:
a. Corrosion-resistant primer for field paint finish.
2. Manufacturers:
a. Fry Reglet Corporation.
3. Provide factory-fabricated "T", "L", and "cross" intersections.

F. Mullion to Partition Connection Trim (09 2116.MCT)
1. Material: Aluminum
2. Finish: Anodized
3. Products:
a. BASIS OF DESIGN: Mull-it-Over Products; Classic Sound Barrier Mullion Trim Cap 55; www.mullitoverproducts.com.
1) STC: 55
2) Provide snap cover to conceal fasteners.
3) Provide compressible gasket between trim and glass.
b. Gordon, Inc; Mullion Mate 3 High STC; www.gordon-inc.com.
1) STC: 52
2) Provide extruded Mullion Mate End Cap for wall termination.
3) Provide gasket with adhesive on both sides of Mullion Mate.
4) Provide acoustical caulk on both sides of Mullion Mate.

G. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
1. Joint Compound:
a. General Interior Use: Ready-mixed vinyl-based joint compound. All-purpose taping and topping compound: type specifically formulated for embedding tape and accessories, for prefilling, and for finishing drywall.
b. Abuse or Impact-Resistant Board: Provide ready mixed or setting type compound as recommended by abuse-resistant board manufacturer.
c. Glass mat faced gypsum backing board: Tile setting compound as specified in tile section.
2. Joint Tape:
a. Gypsum wallboard: Provide manufacturer's standard paper type tape.

b. Abuse or Impact-Resistant Board: Provide paper type or fiberglass as recommended by the abuse resistant board manufacturer.
c. Glass mat faced backer board: 2 inches (51 mm)-wide fiberglass mesh tape.

H. Screws: ASTM C1002; self-piercing tapping type, lengths as recommended by gypsum board manufacturer for project conditions.
1. Provide corrosion resistant screws for glass mat faced gypsum backing board.

I. Furring Fasteners/Connectors: Manufacturer's recommended system for specific application indicated, complying with ASTM C754.

J. Hanger Wire: ASTM A641/A641M, soft, Class 1 galvanized.
1. Ceiling hangers: Minimum 8 gauge, 0.16 inch (4.06 mm) wire.
2. Furring channel ties: Minimum 18 gauge, 0.048 inch (1.22 mm) wire.

K. Blocking: Provide metal blocking for mounting of wall cabinets, shelves, toilet accessories, etc.
1. Provide ___ inch (___ mm), 16 gauge, 0.064 inch (1.62 mm), steel runner notched to bypass steel studs and secured with two 3/8 inch (10 mm) pan head screws.

2.04 ACOUSTICAL MATERIALS

A. Sound Attenuation Batts: ASTM C665, Type I; unfaced semirigid mineral wool batt (made from rock or slag); thickness as follows:
1. Use 1-1/2 inch (38 mm) batts in 1-5/8 inch (41 mm) studs.
2. Use 2 inch (51 mm) batts in 2-1/2 inch (64 mm) studs.
3. Use 3 inch (76 mm) batts in 3-5/8 inch (92 mm) and wider studs.
4. Where batts are required in furred spaces, use batt thickness equal to furring depth.

B. Acoustical Sealants:
1. Concealed Locations: ASTM C919. Acrylic emulsion latex or water-based elastomeric sealant. Recommended by manufacturer for use in acoustical sealing applications.
2. Exposed Locations: Joint sealant specified in Section 07 92 00 - Joint Sealants.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions and substrates are appropriate for work of this section to commence.

B. Coordinate installation of anchorage devices for suspended ceilings/soffits, verifying that spacing and rated strength are correct for anticipated load conditions.

3.02 FRAMING INSTALLATION

A. Comply with ASTM C754 and manufacturer's instructions.

B. Fire-rated assemblies: Comply with requirements of tested assemblies.

C. Studs:
1. Extend partitions to structure unless otherwise indicated.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
4. Slab Deflection: At fire-rated partitions, construct slip-joint head in accordance with UL-witnessed reports and manufacturer's recommendations.

D. Partition heights:
1. Where not indicated otherwise, extend partitions from floor to underside of solid structure above.
2. Where indicated, extend partitions to underside of suspended ceiling or to just above suspended ceiling, as indicated.

a. Brace partial height partitions in accordance with design requirements specified in Part 1 of this Section.

3. Blocking and bracing: Install blocking and bracing as recommended by manufacturer for adequate support of wall-mounted items installed as work of other sections.

E. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double 20 gauge, 0.036 inch (0.91 mm), side-by-side studs at jambs on both sides of opening.
1. At openings in fire rated partitions, comply with requirements of governing authorities for framing.

F. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches (100 mm) from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches (600 mm) on center.
1. Orientation on solid walls: Vertical.

G. Blocking: Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, shelving, and other fixture mounted on partitions. Screw steel blocking channels to studs.

H. Suspended Ceilings and Soffits:
1. Secure hangers to structure or to anchorage devices so that full strength of hanger can be achieved.
a. Install ceiling channels at spacing indicated or required, but not greater than permitted by ASTM C754.
b. Secure furring members to ceiling channels by means of clips or wire ties.
2. Level ceiling system to a tolerance of 1/8 inch (3 mm) in 12 feet (3.65 m), or to a higher tolerance if required by specific project conditions.
3. Level soffits to a tolerance of 1/8 inch (3 mm) in 12 feet (3.65 m), or to a higher tolerance if required by specific project conditions.
4. Reinforce openings and interruptions in horizontal framing system with additional furring channels. Ensure that entire suspension system is laterally braced.

3.03 ACOUSTIC INSULATION

A. Acoustic Insulation: After gypsum board has been installed on one side, place insulation tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions. Fill cavities completely, using recommendations and details indicated in USG Corporation's "Gypsum Construction Handbook".

3.04 NOISE, AIR, AND DUST CONTROL

A. General: Every partition dividing two spaces is a noise, air, and dust control partition.
1. Seal noise, air, and dust control partitions in accordance with the requirements listed below.
2. Seal gypsum panels used on the interior face of exterior walls in the same manner.
3. Seal gypsum furring panels used on masonry in the same manner.

B. Seal perimeter of partition with acoustical sealant, complying with recommendations and details in USG Corporation's "Gypsum Construction Handbook" and ASTM C919. Do not install sealant under metal runners. Install 1/4 inch (6 mm) or larger round bead of sealant to in-place runners and adjacent substrate including those used at partition intersections. Immediately place gypsum panel so as to compress bead, leaving 1/8 inch (3 mm) of perimeter relief (or other dimension where indicated) between gypsum panel and adjacent construction. Locate the sealant bead so that the bead seals between the gypsum wallboard, the runner, and the adjacent floor, wall, structure, or other substrate.
1. Relief Joints: Install sealant between metal edge trim and adjacent construction. Joint size 1/4 inch (6 mm) unless otherwise indicated.
2. Install sealant beneath control joints.
3. Install sealant at metal door frames just before inserting face panel.

4. Carefully seal around penetrations such as electrical boxes, plumbing, cabinets, ducts, and other openings.

3.05 GYPSUM BOARD INSTALLATION

A. Comply with ASTM C840 and manufacturer's instructions.. Install to minimize butt end joints, especially in highly visible locations.

B. Fire-rated assemblies: Comply with requirements of tested assemblies.

C. Apply ceiling boards prior to installation of wallboards. Arrange to minimize butt end joints near center of ceiling area.

D. Install wallboards in a manner which will minimize butt end joints in center of wall area. Stagger vertical joints on opposite sides of walls.

E. Butt all joints loosely, with maximum of 1/16 inch (1.5 mm) between boards.

F. Size panels to provide perimeter relief and install over sealant as specified under noise control, above. Do not install panels unless and until sealant is properly installed.

G. Place wrapped edges adjacent to one another; do not place cut edges or butt ends adjacent to wrapped edges.

H. Support all edges and ends of each board on framing or by solid substrate, except that long edges at right angles to framing members in non-fire-rated construction may be left unsupported.

I. Single-Layer: Install gypsum board vertically, with ends and edges occurring over firm bearing.
   1. On walls and partitions, plan installation so that the leading edge or end of gypsum board is attached to open end of stud flange first.

J. Double-Layer Installation: Use gypsum backing board or gypsum wallboard for first layer, placed perpendicular to framing or furring members. Place second layer perpendicular to first layer. Offset joints of second layer from joints of first layer.
   1. In ceiling work, install base layer with long edges perpendicular to framing members, with face layer in opposite direction, and with all joints offset.
   2. In wall work, install base layer with long edges parallel to framing members with face layer in opposite direction, and with all joints offset.
   3. Install face layer by means of screws at least 3/8 inch (10 mm) longer than total thickness of gypsum board layers, spaced as specified for the tested assembly.

K. Glass Mat Faced Gypsum Backing Board:
   1. Install water-resistant backing board on partitions to receive tile.
   2. Butt joints together with 1/8 inch (3 mm) space at joints. Layout work and use appropriate length material to avoid end joints. Joints shall occur over framing members. Stagger end joints between adjacent panels.
   3. Place uncoated rear face against studs, so that coated front face will receive tile or other finish.
   4. Fit panels snugly around penetrations and openings.
   5. Drive fasteners tight against and flush with panel surface. Do not countersink fasteners.
   6. Locate fasteners not closer than 3/8 inch (10 mm) from edge and ends of panels.
   7. Space fasteners at not more than 8 inches (200 mm) on center at perimeter and field, unless closer spacing is indicated on the drawings.

3.06 SHAFT WALL INSTALLATION

A. Comply with manufacturer's printed installation instructions, standard details, and recommendations.

B. Metal Perimeter Framing:
   1. Accurately position runners at floor and ceiling, with short leg to finish room side.
   2. Attach runners to structure with appropriate power-driven fasteners, spaced at not more than 24 inches (600 mm) on center.

3. Install metal studs, struts, or vertical runners as recommended by manufacturer at intersection of shaftwall and structural framing, at corners and T-shaped intersections, and at openings.

C. Shaft Wall Liner:
1. Cut liner panels accurately to a dimension 3/4 to 1 inch (19 to 25 mm) less than wall height. Install sequentially between special metal studs designed to hold liner panels by friction at shaft side of wall.
2. On walls over 16 feet (4.8 m) in height, screw-attach studs to runners top and bottom.
3. When maximum panel length available is less than shaftwall height, position horizontal joint within top third and bottom third of wall, alternating location at adjacent panels.

D. Door Openings:
1. Comply with manufacturer's details for installation of minimum 20 gauge, 0.036 inch (0.91 mm) metal struts or studs at head and jambs. Spot grout one-piece metal frames after liner panels have been installed.
2. Support elevator door frames, accessories, and operating mechanisms independently of gypsum board shaftwall system.

E. Boxes and Recessed Accessories: Maintain fire separation at openings by adding protection behind recessed components in accordance with manufacturer's details for tested assemblies.

F. Structural Support: Provide supplemental blocking, framing, furring, and reinforcement as recommended by manufacturer and as required to properly support elements attached to non-load bearing shaftwall system.

3.07 INSTALLATION OF TRIM AND ACCESSORIES

A. Comply with manufacturer's recommendations for installation of trim items. Except for items intended by manufacturer to be left exposed or semi-exposed, install trim units for concealment in joint finishing compound. Wherever possible, fasten metal trim items to substrate with same fasteners used to install gypsum board products.

B. Control Joints: Where control joints are indicated on the drawings, place control joints as shown on the drawings. Where control joints are not indicated on the drawings, place control joints consistent with lines of building spaces and as follows:
1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
2. Install one-piece control joints at required locations. Do not remove tape until finishing operations are complete.

C. Corner Beads: Install at external corners, unless details clearly indicate its omission at specific locations. Use longest practical lengths.

D. Isolation Joints: Where gypsum board construction abuts cabinetry, windows, structural components, and other dissimilar materials, provide isolation by stopping board a minimum of 1/4 inch (6 mm) from structure, for finishing by means of exposed or semi-exposed trim.

E. Aluminum Trim: Install as indicated on drawings and in accordance with manufacturer's instructions.

3.08 JOINT TREATMENT

A. Finish gypsum board in scheduled areas in accordance with levels defined in ASTM C840.

B. Do not mix joint compounds except as specifically recommended by manufacturer.

C. Joint Treatment for Glass Mat Faced Gypsum Backing Board to Receive Tile:
1. At corners install a bead of urethane joint sealant to seal the corner.
2. Fill joints between backing boards with tile setting mortar.
3. Apply self-adhering fiberglass sheathing tape to all joints, corners, and openings; overlap tape intersections for a width equal to tape width.
4. Embed tape in tile setting material.
5. Allow joints to dry before proceeding with tile installation.

D. Penetrations in Wallboard: Fill cutouts and openings around fixtures and penetrations with joint compound.

E. Penetrations in Gypsum Backing Board: Seal cut edges with elastomeric sealant specified in Division 07.

3.09 CLEANING

A. Promptly remove any residual gypsum drywall materials from adjacent or adjoining surfaces, leaving spaces ready for subsequent finishing operations and decorating.

3.10 FINISH LEVEL SCHEDULE

A. Level 1: Above finished ceilings concealed from view; from 8 inches (200 mm) above suspended ceilings to top of partition.
   1. Embed tape in joint compound at all joints and interior angles; provide accessories only as detailed.
   2. Provide surfaces free of excess joint compound; tool marks and ridges are acceptable.

B. Level 4: Surfaces scheduled to receive the following:
   1. Flat or eggshell paint finish specified in Section 09 91 00 - Painting.
   2. All surfaces not otherwise indicated.
   3. Application:
      a. Embed tape in joint compound at all joints and interior angles.
      b. Provide three separate coats of compound at all joints, angles, fastener heads, and accessories.
      c. Provide smooth surfaces free of tool marks and ridges.

C. Level 5: Walls and/or ceilings scheduled to receive the following:
   1. Wallcovering specified in Section 09 72 00 - Wall Coverings.
   2. Wallcovering specified in Section 09 77 56 - Decorative Wall Surfacing Films.
   3. Application:
      a. Embed tape in joint compound at all joints and interior angles.
      b. Provide three separate coats of compound at all joints, angles, fastener heads, and accessories.
      c. Apply a thin skim coat of joint compound or a special-purpose coating to the entire gypsum board surface.
      d. Provide smooth surfaces free of tool marks and ridges.

D. Finishing Glass Mat Faced Gypsum Backing Board to Receive Tile: As specified under "Joint Treatment", above.

END OF SECTION

SECTION 09 30 00 - TILING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Tile.
   2. Tile setting materials.
   3. Isolation and waterproofing membrane under tile.

1.02 REFERENCES

A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2019.

B. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive.

C. ANSI A108.5 - Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.

D. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile Setting and Grouting Epoxy and Water Cleanable Tile Setting Epoxy Adhesive.

E. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar; 2019.

F. ANSI A137.3 - American National Standard Specifications for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs; 2021.

G. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2021.

1.03 SUBMITTALS

A. Product Data:
   1. Written product information which demonstrates materials to be used on the project comply with contract documents.
   2. Manufacturer's installation instructions.

B. Installer qualifications.

C. Samples for Verification Purposes: Submit the following:
   1. Submit each tile type selected mounted on a minimum 12 inches (305 mm) square board with joints filled using selected grout.

D. Contractor’s Certificate of Inspection of Waterproofing Membrane.

1.04 QUALITY ASSURANCE

A. Material Source: Furnish each type, finish, and color of tile product and accessory materials from a single supplier.

B. Installer Qualifications for Tile:
   1. Certified Tile Installer (CTI), Certified Tile Education Foundation; https://www.ceramictilefoundation.org.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store tile products and setting materials in manufacturer's sealed packages. Protect material from damage and store in dry location.

1.06 PROJECT CONDITIONS

A. Provide temperatures in tiled areas during installation and after completion as required by referenced installation standard or manufacturer's instructions, but not less than 50 deg F (10 deg C) nor more than 90 deg F (32.2 deg C) unless otherwise approved. For unavoidable conditions outside of this range, obtain material manufacturer's recommendations.

B. If necessary to use temporary heaters, vent units to exterior to protect tile work from carbon dioxide accumulation.

1.07 MAINTENANCE

A. Extra Materials: Deliver supply of maintenance materials to the Owner. Furnish maintenance materials from same lot as materials installed, and enclosed in protective packaging with appropriate identifying labels.
   1. Furnish not less than 2 percent of total product installed maintenance stock for each type, color, pattern, and size of tile product installed.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Ceramic Tile Standard: ANSI A137.1. Tile grade: "Standard Grade," unless noted otherwise.

B. Standard for guaged porcelain tiles and guaged porcelain panels / slabs: ANSI A137.3.

C. Tile Installation Materials Standard: ANSI standard referenced for setting and grouting materials.

D. Colors, Textures, and Patterns, Tile, Grout, and Other Products: Match colors indicated or, if not indicated, as selected by Architect from manufacturer's full range of colors.

E. Color Blending: Factory-blend tile products which have a natural color range so products taken from one box will have the same range as products from a separate box.

F. Tile Mounting: Manufacturer's standard factory back- or edge-mounting.

2.02 TILE MATERIALS

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Floor & Wall Tile:
   1. Tile Type 1 (093000.T1), Basis of Design:
      a. Manufacturer: Daltile
      b. Pattern: Rekindle
      c. Color: Light Grey RK12
      d. Size: 12x24
      e. Grout Color: to be selected from full manufacturers offerings.
      f. Contact: Michele Miller, 704.877.6396, michele.miller@daltile.com
      g. Other Acceptable Manufacturers and Patterns:
         1) Atlas Concorde
            (a) Pattern: Rift
            (b) Color: Gravel
            (c) Size: 12x24
            (d) Grout Color: to be selected from full manufacturers offerings.
            (e) Contact: Ann Hartley, 919-602-6125, ahartley@mosaictileco.com
         2) Best Tile:
            (a) Pattern: Provence
            (b) Color: Ecru
            (c) Size: 12x24
            (d) Grout Color: to be selected from full manufacturers offerings.
            (e) Contact: Nancy Peters, 919.986.6256, npeters@besttile.com

2.03 THRESHOLDS AND TRANSITIONS

A. General:
   1. Fabricate to size to provide transition between tile floor and adjacent floor surface.

2. At door openings, install a single full-width piece; notch threshold to door jamb profile.
3. For tile on gypsum panel underlayment: Use full-thickness threshold / saddle units butted against panels.

B. Products: Refer to Section 09 60 10 - Flooring Transitions.

2.04 SETTING, GROUTING, AND WATERPROOFING MATERIAL MANUFACTURERS:

A. Provide products of a single manufacturer, unless otherwise specified, required, and approved.
1. Exception: Provide the sheet waterproofing products specified.

B. Manufacturers:
1. Custom Building Products.
2. Laticrete International, Inc.
3. Mapei Corporation.

2.05 SETTING MATERIALS

A. Latex-Portland Cement Mortar: Two-component, dry mortar mix and liquid latex additive, field-mixed; complying with ANSI A118.15.
1. All components premeasured and prepackaged.
2. Liquid latex additive: Acrylic or styrene-butadiene resin water emulsion.
3. Mix in accordance with manufacturer's recommendations.
4. "ProLite Thin Set Mortar"; Custom Building Products.
5. "255 MultiMax Thin Set Mortar"; Laticrete International, Inc.
6. "UltraLite Thin Set Mortar"; Mapei Corporation.

B. Organic Adhesive: ANSI A136.1.
1. "AcrylPro Ceramic Tile Adhesive"; Custom Building Products.
2. "Laticrete 15 (136 g/l)"; Laticrete International, Inc.
3. "Ultramastic ECO"; Mapei.

2.06 MEMBRANE MATERIALS

A. Sheet Waterproofing Membrane:
1. Waterproofing Above Sloped Bed: Waterproofing / Vaporproofing Walls: 0.030 inch (0.76 mm) nominal thickness chlorinated polyethylene (CPE), a non-plasticized elastomer, with non-woven polyester laminated to both sides. "NobleSeal TS"; The Noble Company.
a. For individual shower pans and similar applications provide single full-width sheets without laps or splices.
b. Where application width exceeds 4 feet (1.2 m), provide lapped sheets bonded with membrane manufacturer's recommended waterproof adhesive. (Sheet width 5 feet (1.5 m) x roll length.)
c. Bond sheet to sloped substrate .
d. Install tile on top of sheet using thin-set method.
2. Extend sheet up and over curbs, and down outside face approximately 2 inches (50 mm).
3. Extend sheet up walls curb height plus 2 inches (50 mm).
4. At inside corners, fold sheet to form corner without cutting or puncturing such that no additional sealing is required.
5. Provide manufacturer's standard pre-formed corners for use at shower pan dams, curbs, and other outside corners.
6. Provide membrane manufacturer's approved products for joining, fastening, and adhering membrane and for sealing membrane to drains.

2.07 GROUTING MATERIALS

A. Chemical-Resistant, Water-Cleanable Ceramic Tile Setting and Grouting Epoxy: ANSI A118.3.
1. "CEG-Lite 100% Solids Epoxy Grout"; Custom Building Products.
2. "SpectraLock Pro Grout"; Laticrete International, Inc.
3. "Kerapoxy"; Mapei Corporation.

B. Grout Color: Using brand-name products specified above, provide grout matching the color selected by the Architect. Brand names/colors indicated on the finish schedule or plans, if any, denote color, only, not product.

2.08 PATCHING AND LEVELING COMPOUND

A. Portland cement base, acrylic polymer compound, manufactured specifically for resurfacing and leveling concrete floors.

B. Have not less than the following physical properties:
   1. Compressive strength - 4000 psi (27.58 MPa).
   2. Tensile strength - 800 psi (5.56 MPa).
   3. Flexural strength - 850 psi (5.86 MPa).

C. Capable of being applied in layers up to 1 1/2 inches (38 mm) thick, being brought to a feather edge, and being troweled to a smooth finish.

D. Ready for use in 48 hours after application.

2.09 MISCELLANEOUS MATERIALS

A. Tile Cleaner: Acidic tile cleaners are not acceptable. Provide products specifically recommended by grout manufacturer for type of grout and tile used, such as the following:
   1. Commercial detergent or tri-sodium phosphate.
   2. Dry grout powder.
   3. Methyl alcohol.

B. Joint Sealant: Specified in Division 07. Color shall match adjacent grout unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify with the installer that substrate areas where tile is to be installed have been prepared correctly, and that all backing materials have been installed. Correct unacceptable conditions before start of tile work.

B. Verify that concrete substrates have not been cured with membrane-forming curing compounds. The following types of curing are suitable to receive tile or bonded mortar beds:
   1. Continuous moist curing methods.
   2. Moisture-retaining sheet materials.
   3. Membrane-forming curing compounds are acceptable only where thick-bed with cleavage membrane will be installed.

C. Ensure that substrates to receive tiling work conform to TCNA (HB) requirements.

D. Ensure that surfaces to which tile will bond (surface of concrete for direct bonding, surface of thick mortar bed, surface of tile backer board, or other surface) does not vary from true plane by more than:
   1. 1/4 inch in 10 feet nor more than 1/16 inch in 12 inches when measured from high points in the surface for tiles less than 15 inches in length.
   2. 1/8 inch in 10 feet nor more than 1/16 inch in 24 inches when measured from high points in the surface for tiles with any dimension 15 inches or more.

E. Correct unsuitable substrates before proceeding to install tile.

3.02 PREPARATION

A. Factory-Blending: Before start of installation verify that tile with an anticipated range of colors has been correctly blended to achieve a uniform color range from tile package to tile package.

B. Patching and Leveling:
   1. Mix and apply patching and leveling compound in accordance with manufacturer's instructions.

2. Fill holes and cracks and level concrete floors that are out of required plane with patching and leveling compound.
3. Thickness of compound shall be as required to bring finish tile system to elevation shown.
4. Slope compound to drain where drains are shown.

C. Floors:
1. Membrane-forming curing compounds, if used, shall be completely removed by abrasive blast cleaning, vigorous wire brushing, or scarifying. Acid cleaning is not acceptable, unless specifically approved by the Architect.
2. Mortar bed for depressed slabs:
a. Install mortar bed not less than 1-1/4 inch (32 mm) thick unless otherwise indicated.
b. Install setting bed reinforcing centered in mortar fill.
c. Screed finish to level plane, and slope to drains unless otherwise shown.
d. Cure mortar bed fill not less than seven days. Do not use curing compounds or coatings.

D. Walls:
1. Apply patching and leveling compound to concrete and masonry surfaces that are out of required plane.
2. Apply leveling coats of material compatible with wall surface and tile setting material to wall surfaces, other than concrete and masonry, that are out of required plane.

3.03 INSTALLATION - GENERAL

A. Tile Installation Standard:
1. ANSI A108/A118/A136 series, for setting and grouting materials listed.
2. Comply with TCNA (HB) "Handbook for Ceramic Tile Installation" for type of applications indicated.

B. Set tile firmly in place with finish surfaces in true planes.
1. Seal tile joints water tight around electrical outlets, piping fixtures, and fittings before cover plates and escutcheons are set in place.
2. Completed work shall be free from:
a. Hollow sounding areas.
b. Loose or cracked or scratched tile.
c. Out of plane or misaligned tile.
d. Mismatched patterns or colors.
e. Grout haze or other stains.
f. Other defects.
3. Mortar Coverage: Ensure that mortar is well bonded to tile and to substrate accross at least 95% of the area, evenly distributed to support edges and corners, and no voids exceeding 2 square inches and no voids within 2 inches of corners.

C. Install waterproofing to comply with waterproofing manufacturer's instructions as necessary to result in a watertight installation.

D. Install tile under or behind equipment and fixtures.

E. Carefully cut, drill, and grind tile to fit around items projecting through tile surface, so that escutcheons or cover plates conceal cut edges, and without marring tile surface.

F. Joint Patterns: Lay out tile according to patterns indicated on drawings, or if not shown, in a grid pattern with floor joints aligning with wall and trim joints. Install joints straight and of uniform width. Neatly form intersections and returns.
1. Lay out tile work so that no tile less than one-half full size is used. Make all cuts on the outer edge of the field.
2. Joint size, unless otherwise indicated:
a. Wall tile: 1/16 inch (1.5 mm).
b. Ceramic mosaic tile: 1/16 inch (1.5 mm).
c. Quarry tile: 1/4 inch (6 mm).

d. Marble tile: 1/8 inch (3 mm).
e. Other floor tile: As directed by the Architect.

G. Sealant-Filled Joints: Install joints in the locations listed below, and elsewhere indicated on the drawings. Saw-cut joints are unacceptable. Joint installation method: TCA EJ 171.
1. Between floor tile and base tile or other hard finish material at walls, curbs, columns, pipes, and similar conditions.
2. Where changes occur in floor or wall substrates. Locate joint in tile directly over joint in substrate.
3. Where control, construction, or cold joints occur in floor or wall substrates. Locate joint in tile directly over joint in substrate.

H. Remove and reset defective work.

3.04 TRIM

A. Thresholds: Install thresholds (marble or solid surfacing, as indicated) between tile floors and adjacent flooring or other materials where adjacent finish is not flush with top of tile. Install with thin-set mortar where thick mortar bed would be exposed above adjacent floor finish.

3.05 CONCRETE FLOOR APPLICATIONS

A. Application 09 30 00.MBC: Thick-set mortar bed w/ cleavage membrane; TCNA F111.
1. Cleavage membrane: Asphalt-saturated felt.
2. Mortar bed: Portland cement mortar, ANSI A108.1A or B, as indicated in the Contract Documents.
3. Bond coat and grout: As indicated in the Contract Documents.

B. Application 09 30 00.HLE: Horizontal tile, latex mortar; epoxy grout, TCNA F115.
1. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
2. Grout: Epoxy, ANSI A108.6.

C. Application 09 30 00.HWLE: Horizontal tile, waterproof membrane, TCNA F122/F122A; latex mortar, epoxy grout, TCNA F115.
1. Waterproof membrane.
2. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
3. Grout: Epoxy, ANSI A108.6.

3.06 WOOD FRAMED FLOOR APPLICATIONS

A. Application 09 30 00.HBLL: Horizontal tile, backing board over subflooring, latex mortar, latex grout; TCNA F151.
1. Coated glass mat water-resistant gypsum backer board:
a. Butt joints together with 1/8 inch (3 mm) space at joints. Layout work and use appropriate length material to avoid end joints. Stagger end joints between adjacent panels. Stagger end joints between subflooring and panels.
b. Place coated rear face up, so that coated front face will receive tile.
c. Fit panels snugly around penetrations and openings.
d. Laminate panels to subflooring using latex-Portland cement mortar. Embed panels into mortar while mortar is still plastic. Ensure full coverage for complete bonding in accordance wiith TCNA standards.
e. Fasten panels to subfloor with galvanized roofing nails (1 inch (25 mm) longer than thickness of backing board. Drive fasteners tight against and flush with panel surface. Do not countersink fasteners.
f. Locate fasteners not closer than 3/8 inch (10 mm) from edge and ends of panels.
g. Space fasteners at not more than 8 inches on center in all directions.
h. Apply 2 inches (50 mm) 10x10 glass mesh tape over joints, and embed with latex-Portland cement mortar.
i. Thresholds and saddles: Use full-thickness units butted against panels.
2. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
3. Grout: Latex-Portland cement, ANSI A108.10.

B. Application 09 30 00.HMLE: Horizontal tile, membrane over poured gypsum underlayment, latex mortar, epoxy grout; TCNA F180.
   1. Membrane: Crack isolation, sound isolation, or waterproof membrane, as indicated; bonded to substrate. Prime substrate in accordance with membrane manufacturer's instructions before installing membrane.
   2. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   3. Grout: Epoxy, ANSI A108.6.

3.07 OTHER APPLICATIONS

A. Application 09 30 00.BLE: Bathtub walls or prefabricated shower receptor, latex mortar and epoxy grout on walls; TCNA B419.
   1. Tub or prefabricated shower receptor: Specified elsewhere.
   2. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   3. Grout: Epoxy, ANSI A108.6.

B. Application 09 30 00.SLEC: Individual shower w/ curb, waterproof membrane, latex mortar, and epoxy grout on floors and walls; TCNA B420.
   1. Waterproof membrane.
   2. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   3. Grout: Epoxy, ANSI A108.6.

C. Application 09 30 00.SLEA: Individual Shower, Accessible Roll-In w/ waterproof membrane, latex mortar, and epoxy grout on floors and walls.
   1. Recessed slab, thick mortar bed, sloped to drain, with reinforcing: Portland cement mortar, ANSI A108.1B.
   2. Waterproof membrane.
   3. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   4. Grout: Epoxy, ANSI A108.6.

D. Application 09 30 00.S: Stairs; Latex mortar and grout on treads and risers; TCNA S151.
   1. Method F112 on treads; Method W211 on risers.
   2. Mortar bed: Portland cement mortar, ANSI A108.1C.
   3. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   4. Grout: Latex-Portland cement, ANSI A108.10.
   5. Use cove tile at junction of riser and tread. Use finished step nosing tile at nosings.

3.08 WALL APPLICATIONS

A. Application 09 30 00.VAL: Vertical tile, organic adhesive, latex grout: TCNA W242.
   1. Gypsum backing board on walls: Specified Section 09 21 16 - Gypsum Board Assemblies.
   2. Adhesive: Organic adhesive, ANSI A108.4.
   3. Grout: Latex-Portland cement, ASNI A108.10.

B. Application 09 30 00.VLE: Vertical tile, latex mortar, epoxy grout: TCNA W202E/W202I//W245.
   1. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   2. Grout: Epoxy, ANSI A108.6.

C. Application 09 30 00.VLL: Vertical tile, latex mortar, latex grout: TCNA W202E/W202I//W245.
   1. Bond coat: Latex-Portland cement mortar, ANSI A108.5.
   2. Grout: Latex-Portland cement, ANSI A108.10.

3.09 FIELD QUALITY CONTROL FOR WATERPROOFING MEMBRANES

A. Drains:
   1. Sheet waterproofing: Extend waterproof membrane into drain body and secure with clamping ring. Allow bonding adhesives to cure prior to flood testing.

B. Flood test waterproofing prior to installing tile. Place inflatable plumber's balloon or similar device in piping beneath drains. (Device must contact drain pipe, not drain bowl rim.) Fill waterproofed area with water to a depth of 2 inches (50 mm) measured at shallowest point. Allow to stand at least 24 hours. Installation shall be leak-free.

C. Submit flood test field report to the Architect.

3.10 SEALING OF JOINTS

A. Rake out joints for installation of sealant specified elsewhere.
   1. At thick-set assemblies, rake out joint full depth of tile and setting bed.
   2. At thin-set assemblies, rake out joint full depth of tile.
   3. At waterproof membrane assemblies, rake out joint down to but not through waterproof membrane. Do not damage membrane.

B. Install sealant in accordance with requirements specified elsewhere.

3.11 CLEANING AND PROTECTION

A. Clean tile surfaces after installation is complete.
   1. Remove grout residue from tile as soon as possible after tile installation and in strict accordance with manufacturer's instructions.
   2. Tile that is stained or which contains grout haze after cleaning will be considered defective, and shall be removed and replaced with new tile at no cost to the Owner.

B. Replace any broken, chipped, marred, or otherwise damaged tile before final acceptance.

C. Protection: Apply neutral protective cleaner to tile after installation if recommended by tile manufacturer. Overlay completed tile installation with kraft paper for protection from subsequent construction activities.

D. Do not allow any traffic on completed tile floors for minimum 7 days after completion.

E. Remove protection, rinse, and dry tile installations before final review and acceptance.

CONTRACTOR'S CERTIFICATE OF INSPECTION OF WATERPROOFING MEMBRANE:

I certify that I have inspected the Waterproofing Membrane Work specified in this Section in its entirety. None of this Work has been covered by subsequent Work, including setting mortar, tile, or other materials specified in this Section or materials specified in other Sections.

The waterproofing was flood tested on (insert date) _____ and found to be leak-free.

I have inspected the Waterproofing Membrane Work in its entirety. No segment has be left uninspected. Certified this _____ day of _____ , 20___ by

_____
(signature)

_____
(printed name)

on behalf of

_____
(Contractor)

END OF SECTION

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

C. Supplementary acoustical insulation above ceiling.

D. Accessories.

1.02 REFERENCES

A. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.

B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2017.

C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2022.

1.03 SUBMITTALS

A. Product Data: Provide data on suspension system components and acoustical units.

B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.

1.04 PROJECT CONDITIONS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Install acoustical units after interior wet work is dry.

1.05 EXTRA MATERIALS

A. Provide 3 percent of total acoustical unit area of each type of acoustical unit for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Manufacturers; General:
   1. Armstrong World Industries, Inc: www.armstrong.com.
   2. CertainTeed: www.certainteed.com.
   3. USG: www.usg.com.

C. Acoustical Units 1 (095100.AC1): Field
   1. Acoustical Panel: Plastic or vinyl-faced mineral fiber, ASTM E1264, Type IV, Class A, with the following characteristics determined:
      a. Size: 24 x 24 inches (610 x 610 mm).
      b. Thickness: 3/4 inch (19 mm).
      c. Composition: Water felted.
      d. Light Reflectance: Not less than 0.89.
      e. Noise Reduction Coefficient (NRC): Not less than 0.70.
      f. Ceiling Attenuation Class (CAC): Not less than 35.

2. Products:
   a. BASIS OF DESIGN: Armstrong:
      1) Acoustical Panel: Ultima Tegular 1942, tegular edge.
      2) Suspension System: Suprafine XL 9/16 Heavy Duty.
      3) Color: White
   b. Other acceptable manufacturers:
      1) CertainTeed:
         (a) Acoustical Panel: Symphony m 1222BB-75-1, reveal edge.
         (b) Suspension System: Elite Narrow Stab System 9/16 Heavy Duty.
         (c) Color: White
      2) USG:
         (a) Acoustical Panel: Mars Climaplus 86985, fine line edge.
         (b) Suspension System: Centricitee 9/16 Heavy Duty.
         (c) Color: White

D. Acoustical Units 2 (09 51 00.AC2): Restrooms
   1. Acoustical Panel: baked polyester paint or powdercoated mineral fiber, ASTM E1264, Type IV, Class A, with the following characteristics determined:
      a. Size: 24 x 24 inches (610 x 610 mm).
      b. Thickness: 3/4 inch (19 mm).
      c. Composition: Water felted.
      d. Light Reflectance: Not less than 0.86.
      e. Noise Reduction Coefficient (NRC): Not less than 0.70.
      f. Ceiling Attenuation Class (CAC): Not less than 38.
   2. Products:
      a. BASIS OF DESIGN: Armstrong:
         1) Acoustical Panel: Ultima Health Zone Tegular 1936, tegular edge.
         2) Suspension System: Suprafine XL 9/16 Heavy Duty.
         3) Color: White
      b. Other acceptable manufacturers:
         1) CertainTeed
            (a) Acoustical Panel: Symphony m RX 1222B-RXS-1, reveal edge.
            (b) Suspension System: Elite Narrow Stab System 9/16 Heavy Duty.
         2) USG:
            (a) Acoustical Panel: Mars Healthcare Panels 75/30 SLT 86684.
            (b) Suspension System: Centricitee 9/16 Heavy Duty.

2.02 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
   1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.

C. Acoustical Insulation: ASTM C665, unfaced, semi-rigid mineral wool batts (made from rock or slag). 3" thickness.

D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:240.

C. Locate system on room axis according to reflected plan.

D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners in excess of 2 degrees.

J. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
   2. Miter corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Lay directional patterned units with pattern parallel to shortest room axis.

D. Fit border trim neatly against abutting surfaces.

E. Install units after above-ceiling work is complete.

F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

G. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Double cut and field paint exposed reveal edges with manufacturer's recommended paint.

H. Where round obstructions occur, provide preformed closures to match perimeter molding.

I. Lay acoustical insulation as indicated on drawings.

3.04 ERECTION TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

END OF SECTION

SECTION 09 60 10 - FLOORING TRANSITIONS

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data.

B. Verification Samples: Submit two samples, 6 by 6 inch (150 by 150 mm) inch in size illustrating color and pattern for each product specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: As listed in the schedule description below.

B. Other Acceptable Manufacturers, Metal:
   1. Blanke International; https://www.blankecorp.com/blanke-usa/
   2. Ceramic Tool Company; https://www.ceramictool.com/index.html
   3. Tredsafe; https://tredsafe.com/
   4. National Metal Shapes, Inc.; https://www.nationalmetalshapes.com/

C. Other Acceptable Manufacturers, Resilient:
   1. Roppe; https://roppe.com/
   2. Mannington Commercial; https://www.manningtoncommercial.com/products/accessories/moldings-and-finishings/

D. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS

A. Provide the products listed in the schedule, below.

B. Substitutions: Refer to Section 01 60 00 - Product Requirements.

DESCRIPTION; A - K ARE TO BE USED AT NON TERRAZZO FLOORING TRANSITION AREAS.

A Metal Schluter Reno-TK, Size appropriate for material thicknesses.

B Metal Schluter-Reno-U, Size appropriate for material thicknesses.

C Metal Schluter-SCHIENE, Size appropriate for material thicknesses.

D Metal Schluter-RENO-T, Size appropriate for material thicknesses.

E Metal Schluter-RENO-RAMP, Size appropriate for material thicknesses.

F Resilient Tarkett Johnsonite CTA-XX-H, 1/8 to 1/4 inch (3 to 6 mm)

G Resilient Tarkett Johnsonite CTA-XX-J, 0 to 1/4 inch (0 to 6 mm)

H Resilient Tarkett Johnsonite CTA-XX-X, 0.08 to 1/8 inch (2 to 3 mm)

J Resilient Tarkett Johnsonite CTA-XX-D, 0 to 1/2 inch (0 to 13 mm)

K Resilient Tarkett Johnsonite CD-XX-B, 1/8 to 1/2 inch (3 to 13 mm)
1. Color: Architect/Designer to select from manufacturers full offerings.

L Solid Surfacing: Homogeneous quartz and resin matrix. To be used at all locations that transition from terrazzo flooring to another flooring material.
1. Color 1 (096010.SST1); offices: to be selected by the Architect/designer from manufacturer's full range.
2. Color 2 (096010.SST2); restrooms: to be selected by the Architect/designer from manufacturer's full range.
   Manufacturers:
   Cambria USA.

Dupont, Zodiaq.
Caesarstone USA, Inc.

M Divider Strips: 1/8 inch (3 mm) thick brass exposed top strip, brass concealed bottom strip, with anchoring features.

N No Transition Required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Coordinate and install transitions between each type of flooring in accordance with the table above and the respective flooring specifications.

END OF SECTION

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient tile flooring.
   1. Rubber tile.

B. Resilient stair covering.
   1. Treads.

C. Resilient base.

D. Installation accessories.

1.02 REFERENCES

A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2021.

B. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.

C. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.

D. ASTM F2169 - Standard Specification for Resilient Stair Treads; 2015 (Reapproved 2020).

E. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2011.

F. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2017).

1.03 SUBMITTALS

A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions. Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

B. Verification Samples: Submit two samples, 6 bx 6 inch (150 x 150 mm) in size illustrating color and pattern for each product specified.

1.04 FIELD CONDITIONS

A. Maintain temperature in storage area between 65 to 85 degrees F (18 to 29 degrees C).

1.05 EXTRA MATERIALS

A. Provide 5 percent of installed resilient product of each type and color specified.

PART 2 PRODUCTS

2.01 MATERIALS - TILE FLOORING

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Rubber Tile 1 (096500RT1): ASTM F1344, Class I; homogeneous rubber tile with color and pattern throughout thickness.
   1. Products:
      a. Roppe; Rubber Floor Tile: www.roppe.com.
         1) Size: 19-11/16 x 19-11/16 inches (500 x 500 mm).
         2) Color: to be selected by architect/designer from manufacturers full offerings..
         3) Style: Raised circle.
      b. Mannington; Rubber Floor Tile: www.manningtoncommercial.com.
         1) Size: 19-11/16 x 19-11/16 inches (500 x 500 mm).
         2) Color: to be selected by architect/designer from manufacturers full offerings. .

3) Style: Raised circle.
c. Tarkett; Rubber Floor Tile: www.tarkett.com.
1) Size: 24 x 24 inches (610 x 610 mm).
2) Color: to be selected by architect/designer from manufacturers full offerings. .
3) Style: Raised circle.

2.02 MATERIALS - STAIR COVERING

A. Manufacturers:
1. Mannington Commercial: www.manningtoncommercial.com.
2. Roppe: www.roppe.com.
3. Tarkett: www.tarkett.com.

B. Stair Treads: ASTM F2169, Type TS Rubber; full width and depth of stair tread in one piece; tapered thickness.
1. Style:
a. Raised circle.
b. Color: to be selected by architect/designer from manufacturers full offerings.
c. Insert strip: Contrasting color as recommended by manufacturer for code compliant contrasting color based on selection of tread overall color by architect/designer..
2. Nosing: Square.

C. Stair Risers: Full height and width of tread in one piece, matching treads in material and color.

2.03 MATERIALS - BASE

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Resilient Base 1 (096500.RB1): ASTM F1861, Type TS vulcanized thermoset rubber. (offices)
1. Height: 4 inches (102 mm).
2. Finish: Matte.
3. Style: Cove.
4. Length: Roll, 120 feet. (Roll, 36.6 m).
5. Products:
a. BASIS OF DESIGN: Tarkett; Johnsonite BaseWorks: www.tarkett.com.
1) Color: Burnt Umber 63.
b. Other acceptable manufacturers:
1) Mannington Commercial; Burkebase TS: www.manningtoncommercial.com.
(a) Color: BlackBrown 553.
2) Roppe Corp; Pinnacle: www.roppe.com.
(a) Color: Black Brown 193.

2.04 ACCESSORIES

A. Subfloor Filler: Portland cement-based premix latex; type recommended by flooring manufacturers.

B. Primers and Adhesives:
1. Provide primers, adhesives, and other floor preparation and installation products recommended by flooring manufacturer and adhesive manufacturer to suit the project conditions encountered (moisture, pH, absorption, etc.).
2. Provide adhesives complying with SCAQMD 1168 Rule.
a. Rubber Floor Adhesives: 60 g/l.
b. Vinyl, Linoleum, LVT, and all other Flooring Adhesives: 50 g/l.
c. Cove Base Adhesives: 50 g/l.

C. Transitions:
1. Products: Refer to Section 09 60 10 - Flooring Transitions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are smooth and flat within the tolerances specified for that type of work, are free of substances which would impair bonding of adhesive materials, and are ready to receive resilient product.

B. Absorption of Concrete Substrates: Perform water drop test recommended by flooring manufacturer.

C. Verify that concrete subfloor surfaces are ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710. Provide primers, adhesives, and other floor preparation and installation products recommended by flooring manufacturer and adhesive manufacturer to suit the project conditions encountered (moisture, pH, absorption, etc.).

3.02 PREPARATION

A. Remove existing resilient floor covering in accordance with RFCI (RWP) Recommended Work Practices for Removal of Resilient Floor Coverings.

B. Remove existing adhesive residue.

C. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.

D. Wood subfloors must be rigid, free from movement and have at least 18 inches (460 mm) of well-ventilated air space below.

E. Wood floors must be double construction with a minimum thickness of 1 inch (25 mm). The top layer of wood shall be American Plywood Association (APA) Underlayment Grade Plywood.

F. Clean substrate.

3.03 INSTALLATION - TILE FLOORING

A. Install in accordance with manufacturer's instructions.

B. Mix tile from different containers to ensure shade variations are consistent when tile is placed.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Set flooring in place, press with heavy roller to attain full adhesion.

E. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern, unless indicated otherwise in drawings.

F. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.

G. Install transition strips at unprotected or exposed edges, where flooring terminates, and where indicated.

H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - STAIR COVERING

A. Install stair coverings in one piece for full width and depth of tread. Adhere over entire surface. Fit accurately and securely.

B. Install stringers configured tightly to stair profile.

3.05 INSTALLATION - BASE

A. Cut vertical joints and fit tightly. Maintain minimum dimension of 18 inches (45 mm) between joints.

B. At external corners, v-cut back of base strip to two-thirds of its thickness and fold.

C. Miter cut internal corners.

D. Install base on solid backing. Bond tightly to surfaces.

E. Scribe and fit to door frames and other interruptions.

F. Fixed Casework: Provide resilient base at all fixed casework unless otherwise indicated.

3.06 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

3.07 PROTECTION OF FINISHED WORK

A. Prohibit traffic on resilient flooring for 48 hours after installation.

B. Protect installed products until completion of project.

END OF SECTION

SECTION 09 66 23 - RESINOUS MATRIX TERRAZZO FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thin-set epoxy terrazzo.

B. Crack detailing installation.

C. Thin-set epoxy terrazzo base.

D. Refinishing of Existing Portland Cement Terrazzo floor and base.
   1. Cleaning and refinishing of existing terrazzo.
   2. Patching of minor chips and holes in existing terrazzo.
   3. Repair of minor cracks in existing terrazzo.
   4. Infill of demolished terrazzo.

1.02 REFERENCES

A. ASTM D2370 - Standard Test Method for Tensile Properties of Organic Coatings; 2016 (Reapproved 2021).

B. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.

C. NTMA (SPECS) - Terrazzo Specifications; The National Terrazzo and Mosaic Association, Inc.; current edition located at www.ntma.com

1.03 SUBMITTALS

A. Product Data:
   1. Provide data for divider strips, control joint strips, expansion joints, and sealer.
   2. Provide product data for epoxy terrazzo matrix, matrix pigments, aggregate, curing compound, gourt, sealer, seal remover, cleaner, and include a copy of the current NTMA recommendations.

B. Samples: Provide the following:
   1. Epoxy Terrazzo: 6 x 6 inches (150 x 150 mm) in size illustrating color, chip size and variation, chip gradation, matrix color and typical divider strip to matching existing portland cement color. Provide samples for each color.
      a. Following cleaning of existing floor, make up an initial set of range samples to color match the cement paste & aggregates in the floor.
      b. Polish cured samples for comparison by Architect with the cleaned floor for approval.
   2. Accessories: 6 inches (150 mm) long divider strip and control joint strip.

C. Cleaning and Maintenance Data: Include procedures for stain removal, stripping, and sealing.

D. Qualifications: Submit proof of installer and manufacturer membership in NTMA.

E. Shop Drawings: Indicate divider strip and control joint layout, and details of adjacent components.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with NTMA recommendations as posted at their web site at www.ntma.com.

B. Installer Qualifications: A qualified installer who is acceptable to epoxy terrazzo manufacturer to install manufacturer's products.
   1. NTMA member.
   2. Approved by epoxy terrazzo manufacturer.
   3. Not less than five years experience and with at least three projects of comparable scope and complexity of at least 50 percent of total square footage of this project.

C. Pre-installation Conference: Conduct conference at Project site. Review methods and procedures related to terrazzo including, but not limited to, the following:

1. Inspect and discuss installation procedures, joint details, jobsite conditions, substrate specification, vapor barrier details and coordination with other trades.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review existing conditions that are to be matched.
4. Review special terrazzo designs and patterns.
5. Review dust-control procedures.
6. Review plans for concrete curing and site drying to enable timely achievement of suitable slab moisture conditions in accordance with Part 3 - Execution..

D. Mock-Up: Install mock-up to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
1. For epoxy terrazzo, install mock-up of at least 100 sq.ft. (9 sq.m) of typical flooring and base condition for each color and pattern in locations directed by Architect.
2. Provide mock-up of each specified cleaning method in area approximately 4 feet by 4 feet and representing the full extent of conditions to be encountered on the project. Mock-up area shall include all terrazzo colors present in the floor. Following approval of cleaning, this area shall be used to match repair materials. Mock-up shall dry for at least 3 days prior to review.
3. Perform mock-up of 2 lineal feet of crack repair.
4. Perform mock-up of one patch repair.
5. Perform mock-up of finishing including initial grinding, grouting, fine grinding and sealer application. Mock-up shall be used to confirm the extent of grinding and the final finish desired. Two sheens of sealer are specified and the mock-up shall determine which will be used.
6. All related submittals shall be reviewed and approved prior to beginning mock-ups.
7. Mock-up, if approved, may become part of the completed work if undistrubed at time of Substantial Completion.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Store resin materials in a dry, secure area.

B. Maintain minimum temperature of 55 degrees F (13 degrees C).

C. Keep products away from fire or open flame.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not install terrazzo when temperature is below 50 degrees F (10 degrees C) or above 90 degrees F (32 degrees C).

B. Maintain temperature within specified range 24 hours before, during, and 72 hours after installation of flooring.

C. Verify that the dew point is at least 5 deg F (-15 deg C) less than the slab and air temperature.

D. Provide ambient lighting level of 50 ft candles (540 lx), measured at floor surface.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Epoxy Terrazzo:
1. Terrazzo & Marble Supply Companies; Terroxy Resin Systems. www.tmsupply.com.
2. Master Terrazzo Technologies; Morricite Thinset Epoxy: www.masterterrazzo.com.
3. General Polymers; Thin-Set Epoxy Terrazzo No. 1100: www.generalpolymers.com.

2.03 EPOXY TERRAZZO

A. Thickness: 3/8 inch (9 mm).

B. Custom Mix 1 to match existing:
   1. Matrix Color: Color to match existing Terrazzo; site visit required.
   2. Aggregate Size and Percentages:
   3. Aggregate Name 1: Match existing, site visit required.
      a. Size: No. 0
      b. Percentage: 10%
   4. Aggregate Name 2: Match existing, site visit required.
      a. Size: No. 1
      b. Percentage: 70%
   5. Aggregate Name 2: Match existing, site visit required.
      a. Size: No. 0
      b. Percentage: 10%
   6. Aggregate Name 2: Match existing, site visit required.
      a. Size: No. 0
      b. Percentage: 10%

2.04 MATERIALS

A. Epoxy Matrix: Two component resin and epoxy hardener with mineral filler and color pigment, non-volatile, thermo-setting.

B. Aggregate: Crushed marble, size in accordance with NTMA Plate of standard gradation and uniform coloration.

2.05 ACCESSORIES

A. Flooring Transitions: Refer to Section 09 60 10 - Flooring Transitions.

B. Divider Strips: 1/8 inch (3 mm) x 18 guage thick brass exposed top strip, brass concealed bottom strip, with anchoring features.

C. Control Joint Strips: 1/8 inch (3 mm) x 18 gauge nominal width brass exposed top strips, brass concealed bottom strips.

D. Flexible Epoxy Membrane: 100 percent solids for full coverage with the following properties:
   1. Tensile Strength: ASTM D2370, 68 deg F (20 deg C).; 1,500 psi (10.34 MPa).

E. Control Joint Filler: 100 percent solids flexible, grindable epoxy joint filler in color selected by Architect to match or complement terrazzo system.

F. Cleaner: Neutralizing liquid type, pH of 7.

G. Sealer: Medium gloss acrylic sealer, low viscosity, clear acrylic finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat and are ready to receive terrazzo.

B. Verify that wall surfaces are smooth and flat .

C. Verify that sub-floor surfaces are dust-free, and free of substances which would impair bonding of materials to sub-floor surfaces.

D. Verify that wood sub-floors have 12 percent maximum moisture content.

E. Examine substrate and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected. Examine areas to receive terrazzo for:
   1. Defects in existing work that affect proper execution of terrazzo work.

F. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION FOR NEW EPOXY TERRAZZO

A. Clean substrate of foreign matter.

B. Prepare concrete substrate to open surface pores by means of vacuum shotblasting or with a terrazzo grinder, dry with coarse diamond stones with a vacuum unit. Achieve a CSPD-CSP5 profile according to International Concrete Repair Institute Guideline No. 03732. Remove contaminating or bond breaking substances including but not limited to dust, laitance, curing compounds, coatings, sealers, oil, and grease. Chemically remove oil or grease not removed by vacuum blasting. Remove spalled or deteriorated concrete by scabbling or chipping hammers. Acid etching is not acceptable.

C. Repair or level damaged concrete with epoxy fill mortar. Latex fills or self-leveling underlayments are not acceptable.

D. Cracks and non-expansion joints greater than 1/16 inch (1.5 mm) wide after surface preparation shall be prepared until sound.

3.03 PREPARATION FOR EXISTING CEMENTIOUS TERRAZZO RESTORATION

A. Existing terrazzo floors and base that are to remain as an exposed finish are to be fully stripped, grinded, grouted, polished and sealed with water base acrylic sealer.

B. Cover and protect all adjacent finished surfaces during restoration process.

C. Remove all debris.

D. Remove existing patches in terrazzo surfaces.

E. Remove remnants of utilities stubbed through floor. Cut old utilities below concrete floor slab.

F. Repair or level damaged concrete with epoxy fill mortar. Latex fills or self-leveling underlayments are not acceptable.

G. Verify that sub-floor surfaces are dust-free and free of substances which would impair bonding of materials to sub-floor surfaces.

H. Verify that required floor-mounted utilities are in correct location.

I. Perform a thorough examination of the existing conditions. Perform any necessary tests on an inconspicuous surface to determine the current conditions and appropriate steps and materials necessary for stripping terrazzo surfaces.

J. Contractor shall strip surface of all topical coatings and treatments on floor.

K. Strip existing sealers and coatings from floor:
   1. Apply seal remover with a low pressure spray and let stand for five to ten minutes. Scrub surface with a stiff bristle brush. Work in areas no more than four feet wide to insure that the applicator is always standing on a dry floor.
   2. Using a low pressure tank sprayer, apply a mist of water over the cleaner already on the floor.
   3. Pick up all remaining residues with a wet vac.
   4. Using a power scrubber with a scrub brush attachment, scrub the floor until all coating material has been removed.
   5. Pick up all liquid residues with a wet vac.
   6. Thoroughly rinse the surface with clean, clear water.
   7. Pick up all remaining liquid residues with a wet vac and allow to dry.

L. If floor is not fully clean following stripping, clean using the specified Cleaner.
   1. Dilute cleaner per manufacturer’s instructions.
   2. Pre-wet area to be cleaned.
   3. Apply cleaning solution with floor scrub brushes or low pressure spray.

4. Let stand one to ten minutes based on mock-up results. Gently scrub heavily soiled areas. Do not allow cleaner to dry on the surface. If drying occurs, lightly wet surfaces with fresh water and reapply the cleaner in a gentle scrubbing manner.
5. Thoroughly rinse the surface with clean, clear water.
6. Pick up all remaining liquid residues with a wet vac and allow to dry.
7. Repeat process if needed to thoroughly clean surface.

M. Patching of holes:
1. Surface Preparation:
a. With a power saw or hand tools, cut a vertical perimeter wall around the area to be patched. If the patch is smaller than an inch square, slightly undercut this edge.
b. Clean surface of debris. Saturate void with water to prevent quick surface drying. Ensure that water penetrates into the surface in order to achieve a proper bond. Clean surfaces until any obstructing material has been removed.

N. Repair of small cracks:
1. Clean cracks by mechanical means (metal dental pick or small “dremel” tooling) to remove dirt, debris, and sealers. Do not rout out or widen the crack.
2. Fill cracks with grout to match the existing adjacent matrix, using mixture composition from approved mock-up.
3. Allow repair to cure.

O. Fill any large voids with matching terrazzo mix. Grout all pinholes, matrix voids, cracks, and fissures with matching epoxy colored resin or clear resin.

P. Allow 24 hours for resin and grout to cure.

Q. Polish the entire floor as specified in finishing.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NTMA’s written recommendations for terrazzo and accessory installation.

B. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer’s written instructions and NTMA’s “Guide Specification for Epoxy Terrazzo.”

C. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.

D. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.

3.05 PREPARATION FOR EPOXY TERRAZZO INSTALLATION WITH CRACK DETAILING

A. Divider and Accessory Strips: Install in locations indicated in adhesive setting bed without voids below strips.

B. Control-Joint Strips: Install back to back directly over concrete control and now-doweled construction joints leaving a space appropriate for anticipated movement- typically 1/4 inch (6 mm) to 3/8 inch (10 mm). Fill gap between control joints with joint filler.

C. Cracks and Non-Expansion Joints:
1. Type 1 - Hairline cracks shall receive detail coat of epoxy primer with 6 inches (150 mm) fiberglass tape.
2. Type 2 - Fill cracks greater than hairline but less than 1/16 inch (1.5 mm) wide after surface preparation with neat, epoxy membrane. Place detail coat of membrane over crack and embed 12 inches (305 mm) fiberglass cloth. Lightly abrade or solvent wipe treated cracks prior to applying primer.
3. Type 3 - Fill cracks greater than 1/16 inch (1.5 mm) with flexible epoxy membrane. Place 25 - 30 mils (0.63 - 0.76 mm) detail coat so that membrane extends at least 9 to 12 inches (230 to 305 mm) on each side of crack or joint. After membrane has leveled, lay precut membrane fabric into wet membrane. Smooth cloth with a flat steel trowel, allowing cloth to be encapsulated but remain exposed on the surface of membrane. Lightly abrade, or solvent wipe, treated cracks prior to applying primer. Allow in base bid for above crack

detailing as follows: 5 percent of lineal footage of total project square footage for combined Type 1 & 2, and 3 percent of lineal footage of Type 3.

D. Primer: Apply epoxy primer evenly over prepared substrate, cracks and non-expansion joints at the rate of 200 - 300 sq.ft/gal (5 - 7.3 sq.m/l) for normal concrete, to thoroughly wet surface, but avoiding ponding the material. Highly porous concrete may require additional material.

3.06 APPLICATION - TERRAZZO

A. Mix terrazzo binder with chips and fillers in ratios as approved by manufacturer.

B. Trowel apply terrazzo mixture over epoxy primer to provide smooth seamless surface at a minimum of 3/8 inch (10 mm) thick. Allow cure per manufacturer’s recommendations prior to grinding operations.

C. Flush Vertical Base: Bond topping to wall.

3.07 FINISHING

A. Finish terrazzo to NTMA requirements.

B. Rough Grinding: Grind with 24 or finer grit stones or with comparable diamond plates.

C. Intermediate Grinding: Follow initial grind with 80 or finer grit stones.

D. Grouting:
1. Cleanse floor with clean water and rinse thoroughly.
2. Remove excess rinse water by wet vacuum and machine until completely dry.
3. Apply epoxy grout to fill voids.

E. Fine Grinding: Grind with 120 grit stones until all grout is removed from surface. Repeat rough grinding, grout coat, and fine grinding if large voids exist after initial fine grinding. Produce surface with a minimum of 70 percent aggregate exposure.

F. Hand grind base and cove similarly.

G. Remove and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo.

3.08 INSTALLATION TOLERANCES

A. Maximum Variation from Flat Surface: 1/8 inch in 10 feet (3 mm in one m).

B. Maximum Variation from Level (Except Surfaces Sloping to Drain): 1/8 inch (3 mm).

C. All patches and crack repairs shall be smooth and aligned with edges of adjacent existing terrazzo.

3.09 CLEANING

A. Scrub and clean terrazzo surfaces with cleaner in accordance with manufacturer's instructions. Let dry.

B. Immediately after terrazzo has dried, apply sealer in accordance with manufacturer's instructions.

C. Seal and polish surfaces, in accordance with manufacturer's instructions.

3.10 PROTECTION OF FINISHED WORK

A. Do not permit construction traffic over finished terrazzo surfaces.

END OF SECTION

SECTION 09 68 13 - TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

B. Removal of existing carpet tile.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

B. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

C. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03 REFERENCE STANDARDS

A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).

B. CRI 104 - Standard for Installation of Commercial Carpet; 2015.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

C. Shop Drawings: Indicate layout of joints and direction of carpet pile.

D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in installing carpet tile with minimum five years documented experience and approved by carpet tile manufacturer.

1.06 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Tile Carpeting for Offices (096813.CT1):

1. BASIS OF DESIGN: Shaw Contract: www.shawcontract.com.
    a. Product/Style: In Tune 5T496
    b. Color: Merge 50518
    c. Size: 9x36
    d. Installation Pattern: Ashlar
    e. Tufted Weight: 17oz.
    f. Construction: Multi-level Pattern Loop
    g. Fiber: Ecosolution Q Dyed Nylon
    h. Dye Method: 100% Solution Dyed
    i. Protective Treatments: SSP Shaw Soil Protection.

j. Representative Contact: Michelle Parrish, michelle.parrish@shawcontract.com, 919.609.9033 c

2. Other acceptable manufacturers:
   a. Mannington Commercial: www.manningtoncommercial.com#sle.
      1) Product/Style: Summit
      2) Color: Custom Color; coordinate with architect/designer on yarn colors and percentages.
      3) Size: 12"x48"
      4) Representative Contact: Joyce Cavin, Joyce.cavin@Mannington.com, 919.538.1800 c
   b. Mohawk Group: www.mohawkgroup.com/#sle.
      1) Product/Style: Distressed Twill
      2) Color: Custom Color; coordinate with architect/designer on yarn colors and percentages.
      3) Size: 12"x36"
      4) Representative Contact: Lori Zeto, lori_zeto@mohawkind.com, 919.302.6652 c

C. Tile Carpeting for Huddle / Meeting Rooms (096813.CT2):
   1. BASIS OF DESIGN: Mohawk Group: www.mohawkgrop.com.
      a. Product/Style: Biotope
      b. Color: Morel 978
      c. Size: 12x36
      d. Installation Pattern: Ashlar
      e. Tufted Weight: 23oz.
      f. Construction: Tufted
      g. Fiber: Duracolor Tricor Premium Nylon
      h. Dye Method: 100% Solution Dyed
      i. Representative Contact: Lori Zeto, lori_zeto@mohawkind.com, 919.302.6652 c
   2. Other acceptable manufacturers:
      a. Bentley Mills: www.bentleymills.com.
         1) Product/Style: Redacted 8RF23
         2) Color: Document 801532
         3) Size: 18x36
         4) Representative Contact: Christy Bennett, christy.bennett@bentleymills.com, 336.676.2935 c
      b. Shaw Contract: www.shawcontract.com
         1) Product/Style: Gather, Linen Tile
         2) Color: Custom Color to match basis of design; coordinate with architect/designer on yarn colors and percentages.
         3) Size: 18"x36"
         4) Representative Contact: Michelle Parrish, michelle.parrish@shawcontract.com, 919.609.9033 c

D. Tile Carpeting for Classrooms:
   1. BASIS OF DESIGN: J&J Flooring: https://www.jjflooringgroup.com/ (096813.CT3; field)
      a. Product/Style: Kinetex, Z Factor
      b. Color: Analysis
      c. Size: 24x24
      d. Installation Pattern: Ashlar
      e. Representative Contact: Tim Baucom, tim.baucom@jjflooring.com, 919.412.2180 c
   2. BASIS OF DESIGN: J&J Flooring: https://www.jjflooringgroup.com/ (096813.CT4; teaching zone)
      a. Product/Style: Kinetex, Z Factor
      b. Color: Control
      c. Size: 24x24

d. Installation Pattern: Ashlar
e. Representative Contact: Tim Baucom, tim.baucom@jjflooring.com, 919.412.2180 c

3. Other acceptable manufacturers:
   a. EF Contract: (field; 096813.CT3)
      1) Product/Style: Kinetex, Intrigue
      2) Color: to be selected by architect/designer from manufacturers full offerings.
      3) Size: 24x24
      4) Installation Pattern: Ashlar
      5) Representative Contact: King Bostrom, king@kingbostrom.com, 919.606.6213 c
   b. EF Contract: (teaching zone; 096813.CT4)
      1) Product/Style: Kinetex, Vestige
      2) Color: to be selected by architect/designer from manufacturers full offerings.
      3) Size: 24x24
      4) Installation Pattern: Ashlar
      5) Representative Contact: King Bostrom, king@kingbostrom.com, 919.606.6213 c

E. Tile Carpeting for Elevator (096813.CT5):
   1. BASIS OF DESIGN: Mohawk Group: www.mohawkgroup.com.
      a. Product/Style: Tuff Stuff II First Step II
      b. Color: 989 Obsidian
      c. Size: 24"x24"
      d. Installation Pattern: Ashlar
      e. Tufted Weight: 38oz.
      f. Construction: Tufted
      g. Fiber: Duracolor Premium Nylon
      h. Dye Method: 100% Solution Dyed
      i. Representative Contact: Lori Zeto, lori_zeto@mohawkind.com, 919.302.6652 c
   2. Other acceptable manufacturers:
      a. Shaw Contract: www.shawcontract.com
         1) Product/Style: Welcome II
         2) Color: Ebony
         3) Size: 24"x24"
         4) Representative Contact: Michelle Parrish, michelle.parrish@shawcontract.com, 919.609.9033 c
      b. Mannington Commercial: www.manningtoncommercial.com#sle.
         1) Product/Style: Ruffian II
         2) Color: Ebony Earth
         3) Size: 24"x24"
         4) Representative Contact: Joyce Cavin, Joyce.cavin@Mannington.com, 919.538.1800 c
      c. Bentley Mills: www.bentleymills.com
         1) Product/Style: Rough Idea Shear
         2) Color: Shape
         3) Size: 24"x24"
         4) Installation Pattern: Ashlar
         5) Representative Contact: Christy Bennett, christy.bennett@bentleymills.com, 336.676.2935 c

2.02 ACCESSORIES

A. Edge Strips: As specified in Section 09 60 10 - Flooring Transitions.

B. Edge Strips: Embossed aluminum, _____ color.

C. Adhesives:
   1. Compatible with materials being adhered; maximum VOC content as specified in Section 01 61 16.

D. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Remove existing carpet tile.

B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

C. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.

D. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

E. Vacuum clean substrate.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Locate change of color or pattern between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Trim carpet tile neatly at walls and around interruptions.

I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09 72 00 - WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation and prime painting.

B. Wall covering.

1.02 RELATED REQUIREMENTS

A. Section 09 21 16 Gypsum Board Assemblies: Level of Wall finish and mudded in accessories.

B. Section 06 20 00 Finish Carpentry: Chair Rail

1.03 REFERENCE STANDARDS

A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems; 2020.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

C. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics; 2020.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on wall covering and adhesive.

C. Shop Drawings: Indicate wall elevations with seaming layout.

D. Samples: Submit two samples of wall covering, 12 by 12 inch (304.8 by 304.8 mm) in size illustrating color, finish, and texture.

E. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Wall Covering Materials: 25 linear feet (8 linear m) of each color and pattern of wall covering; store where directed.
3. Package and label each roll by manufacturer, color and pattern, and destination room number.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspect roll materials at arrival on site, to verify acceptability.

B. Protect packaged adhesive from temperature cycling and cold temperatures.

C. Do not store roll goods on end.

1.07 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.

B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.01 WALL COVERINGS

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. General Requirements:
   1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
   2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.

C. Wall Covering 1 (corridors): 097200.WC1, complying with the following:
   1. Total Thickness: not less then 0.033 mil (_____ mm).
   2. Total Weight: 33-38 oz/sq yd (_____ g/sq m).
   3. Roll Width: not less then 48 inches (1219.2 mm).
   4. Manufacturers:
      a. BASIS OF DESIGN: MDC Interior Solutions; www.mdcwall.com
         1) Product: Product: Duratec, Palomar
            (a) Color: Hazelnut MDV1041
            (b) Representative Contact: Christa Hochstrasser, chochstrasser@koroseal.com, 919.698.0569
      b. Other acceptable manufacturers:
         1) Momentum textiles, https://momentumtextilesandwalls.com/:
            (a) Product: P3Tec, Simplicity
               (1) Color: Cream P3T-60071
               (2) Representative Contact: Clea Grimm, cgrimm@momtex.com, 919.255.2659
         2) Koroseal, www.koroseal.com
            (a) Product: Traffic Patterns Semi-Rigid; Flex, Junction
               (1) Color: Heir JUN122.
               (2) Representative Contact: Christa Hochstrasser, chochstrasser@koroseal.com, 919.698.0569

D. Wall Covering 2 (classrooms): 097200.WC2, complying with the following:
   1. Total Thickness: Not less then 0.033 mil (_____ mm).
   2. Total Weight: 33-38 oz/sq yd (_____ g/sq m).
   3. Roll Width: not less then 48 inches (1219.2 mm).
   4. Manufacturers:
      a. BASIS OF DESIGN: Momentum textiles, https://momentumtextilesandwalls.com/:
         1) Product: P3Tec, Simplicity
            (a) Color: Pebble P3T-60074
            (b) Representative Clea Grimm, cgrimm@momtex.com, 919.255.2659
      b. Koroseal:
         1) Product: Traffic Patterns Semi-Rigid; Flex, Maguey
            (a) Color: Tangle MGY1-07
            (b) Representative Contact: Christa Hochstrasser, chochstrasser@koroseal.com, 919.698.0569
      c. MDC Interior Solutions; www.mdcwall.com
         1) Product: Duratec, Spartan
            (a) Color: Cobblestone MDV1004

(b) Representative Contact: Katie Chambers, 980.875.8606, kchambers@mdcwall.com

E. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.

F. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

G. Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.

B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.

C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet (3 mm in 3 m) nor vary at a rate greater than 1/16 inch/ft (1.5 mm/300 mm).

3.02 PREPARATION

A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.

B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.

E. Marks: Seal with shellac those that may bleed through surface finishes.

F. Apply two coats of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.

G. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.

B. Use wall covering in roll number or pattern sequence based on manufacturers recommendation..

C. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.

D. Overlap adjacent panels as recommended by manufacturer.

E. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.

F. Do not install wall covering more than 1/4 inch (6 mm) below top of resilient base.

G. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.

B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION

SECTION 09 77 56 - DECORATIVE WALL SURFACING FILMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative wall surfacing films.

1.02 RELATED REQUIREMENTS

A. 09 21 16 - Gypsum Board Assemblies.

B. 08 80 00 - Glazing

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

A. Product Data: Provide data on film and adhesive.

B. Samples: 8 by 10 inches (203 by 254 mm) showing specified color and finish.

C. Installer's qualification statement.

D. Maintenance Data: Maintenance and cleaning instructions.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Trained and certified by film manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Protect films from harmful conditions as recommended by manufacturer.

B. Store films in original packaging, at temperature between 38 and 95 degrees F and relative humidity below 80 percent.

C. Do not use materials beyond one year shelf life.

1.07 FIELD CONDITIONS

A. Do not install films at temperatures below 54 degrees F or above 85 degrees F.

1.08 WARRANTY

A. Manufacturer Warranty: Provide coverage for material and workmanship defects, including, but not limited to reduced gloss, developed texture, decomposition, swelling, clouding, tackiness, crazing, bubbling, and cracking of film.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 6000 - Product Requirements.

2.02 MATERIALS

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. General:

1. Provide graphic film and overlaminate film from single manufacturer.
2. Provide latex ink process for digitally printed films.
3. Color Variation: Graphic film fabrication to use film manufacturer's product appropriate ICC color profiles for graphic processing and production. Graphic film materials within a single continuous area of artwork to be from single roll or product lot.

C. Decorative Wall Surfacing Film 1; 09 77 56.GF1:

1. Application: Digitally printed opaque film installed on primed and latex painted gypsum wallboard.
2. Material: 2 mil, 0.002 inch (0.05 mm) vinyl film.
3. Basis of Design Manufacturer: 3M: www.3m.com/3M/en_US/graphics-signage-us/.
   a. Graphic Film Product: Controltac IJI80.
   b. Overlaminate Product: Scotchcal 8520, matte.
   c. Print Style: Custom graphic provided by Architect.
4. Other Acceptable Manufacturers:
   a. Avery Dennison Graphic Solutions: www.graphics.averydennison.com.
      1) Graphic Film Product: MPI 1005.
      2) Overlaminate Product: DOL 1080.
      3) Print Style: Custom Graphic to be provided by Architect.
   b. Orafol Graphics Products: www.orafol.com/gp/americas/en/frontpage.
      1) Graphic Film Product: Orajet 3751RA.
      2) Overlaminate: Oraguard 290 Matte.
      3) Print Style: Custom graphic provided by Architect.

D. Decorative Glazing Wall Surfacing Film 2; 09 77 56.GF2:
1. Application: Digitally printed transparent film installed on vertical glazing panels.
2. Material: 2mil cast, vinyl film.
3. Basis of Design Manufacturer: 3M: www.3m.com/3M/en_US/graphics-signage-us/.
   a. Overlaminate: Scotchcal Clear View IJ8150
   b. Print Style: Custom Graphic to be provided by archtiect/designer.
4. Other acceptable manufacturers:
   a. Avery Dennison Graphic Solutions; graphics.averydennison.com
      1) Graphic Film Product: SF100-103 Ultra Clear
      2) Overlaminate: DOL 6060
      3) Print Style: Custom Graphic to be provided by architect/designer.
   b. Orafol Graphics Products:; http://www.orafol.com/gp/americas/en/frontpage
      1) Graphic Film Product: Orajet 3751RA Transparent
      2) Overlaminate: Oraguard 290GF
      3) Print Style: Custom Graphic to be provided by architect/designer.

E. Decorative Glazing Wall Surfacing Film 3; 09 77 56.GF3:
1. Application: Vinyl opague film installed on exterior vertical glazing panels (interior side) to block view from exterior into interior and interior to exterior.
2. Material: opaque 2 mil cast, vinyl film
3. UV rated for usage on exterior glazing.
4. Color: Black
5. BASIS OF DESIGN Manufacturer: 3M; https://www.3m.com/3M/en_US/graphics-signage-us/
   a. Product: Controltac Graphic Film Series 180
   b. Color: Black, luster finish
6. Other acceptable manufacturers:
   a. Avery Dennison Graphic Solutions; graphics.averydennison.com
      1) Product: SC950 Cut Vinyl Film
      2) Color: Gloss Black #190
   b. Llumar; http://northamerica.llumar.com/
      1) Product: Series 2100 Cast Film
      2) Color: 03 Black

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work, and comply with requirements of film manufacturer.

B. Verify that openings for glazing, cased openings, & doors, etc. are correctly sized and within tolerance.

C. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Comply with manufacturer's instructions for surface preparation.

B. Coordinate substrate requirements with certified installer.

C. Clean substrate; remove substances that could impair bond.

D. Sand surfaces to achieve proper adhesive bond. Reclean surfaces after sanding is complete. Apply surface sealer and primer as required. Protect prepared surface from contamination until application.

E. Prepare other non-porous substrates to smooth, dry, clean surface free of flaking, unsound coatings, cracks, and defects.

3.03 INSTALLATION

A. Install film in accordance with manufacturer's instructions.

B. Install film smooth, without wrinkles, air bubbles, gaps, visible distortion, or overlaps. Eliminate air pockets and ensure full bond to substrate surface.

C. For three-dimensional components, heat product to mold to substrate so that pattern has continuous, realistic, even appearance.

D. Fit tight to glass perimeter with razor cut edge when in stalled on glass locations.

3.04 CLEANING

A. Consult with certified installer for specific cleaning requirements based on finish, substrate, and applicable environment.

B. Clean completed surfaces in accordance with manufacturer's instructions.

C. Do not use caustic, acidic, or abrasive cleaners.

3.05 PROTECTION

A. Protect completed surfaces from damage using temporary nonstaining coverings recommended by surfacing manufacturer.

3.06 REPAIR

A. Utilize certified installer to repair damaged film using materials and procedures approved by architectural film manufacturer.

END OF SECTION

SECTION 09 91 00 - PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Paints and Coatings on Interior Substrates.
   1. Concrete walls.
   2. Plaster.
   3. Concrete masonry units.
   4. Gypsum board.
   5. Gypsum board ceilings.
   6. Wood trim, painted.
   7. Telephone and electrical panel backers.

D. Paints and coatings on previously painted surfaces.

E. See Schedules at end of this Section.

1.02 REFERENCES

A. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2019.

B. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2007 (Reapproved 2015).

C. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2005 (Reapproved 2017).

D. ASTM D523 - Standard Test Method for Specular Gloss; 2014 (Reapproved 2018).

E. SSPC-SP 3 - Power Tool Cleaning; 2018.

1.03 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

B. Gloss Ranges: Tested in accordance with ASTM D523.
   1. Flat refers to a lusterless or matte finish with a gloss range between 0 and 5 when measured at a 60-degree meter.
   2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
   3. Satin refers to low-to-medium-sheen finish with gloss range between 15 and 35 when measured at a 60-degree meter.
   4. Semi-gloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
   5. Gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.04 SUBMITTALS

A. Product Data: Provide data on all finishing products including:
   1. Manufacturer name.
   2. Product Type.
   3. Product Name.
   4. Product Number.
   5. Color.

B. Samples:

1. Submit two painted samples, illustrating each combination of color and sheen and textures with specified coats cascaded. Submit on hardboard unless otherwise indicated, 8x11 inch (203.2x279.4 mm) in size.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing. Information shall be legible.

C. Use of off-brand containers or mixing buckets will not be allowed on the site.

D. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions. Protect from freezing.

1.06 PROJECT CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Application Temperatures for Waterborne Paints: Minimum 45 degrees F (7 degrees C) for interiors; minimum 50 degrees F (10 degrees C) for exterior; maximum 90 degrees F (32 degrees C), unless required otherwise by manufacturer's instructions. Maintain interior temperatures until paint is completely dry and cured.

C. Application Temperatures for Solvent Thinned Paints: Minimum 50 degrees F (10 degrees C) for interiors and exterior; maximum 95 degrees F (35 degrees C), unless required otherwise by manufacturer's instructions. Maintain interior temperatures until paint is completely dry and cured.

D. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

E. Ventilation: Ventilate affected areas during paint application. Exhaust solvent vapors outdoors, away from air intakes and people.

1.07 EXTRA MATERIALS

A. Supply 1 gallon (4 L) of each color, type, and surface texture of topcoat; store where directed.

B. Label each container with color, type, and texture in addition to the manufacturer's label.

PART 2 PRODUCTS

2.01 VOLATILE ORGANIC COMPOUNDS:

A. Provide interior paints and coatings complying with Green Seal Standard GS-11 Paints, First Edition, May 20, 1993, for VOC content limits as follows:
   1. Non-Flat: 150g/l.
   2. Flat 50 g/l.

B. Provide anti-corrosive and anti-rust paints applied to interior ferrous metal substrates complying with Green Seal Standard GC-03, Anti-Corrosive Paints, Second Edition, January 7, 1997, for VOC content limits as follows:
   1. Flat: 250 g/l
   2. Semi-gloss: 250 g/l.
   3. Gloss: 250 g/l.

C. Provide clear wood finishes, floor coatings, stains, sealers, and shellacs applied to interior elements complying with South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004 for VOC content limits as follows:
   1. Clear wood finishes:
      a. Varnish: 350 g/l.
      b. Lacquer: 550 g/l.

2. Floor Coatings: 100 g/l.
3. Sealers:
   a. Waterproofing Sealers: 250 g/l.
   b. Sanding Sealers: 275 g/l.
   c. All Other Sealers: 200 g/l.
4. Shellac:
   a. Clear: 730 g/l.
   b. Pigmented: 550 g/l.
5. Stains: 250 g/l.

2.02 MANUFACTURERS - PAINTS

A. Benjamin Moore & Co: www.benjaminmoore.com.

B. PPG Paints, Inc.: www.ppgpaints.com.

C. The Sherwin-Williams Co: www.sherwin-williams.com.

2.03 PAINTS AND COATINGS - GENERAL

A. Do not use insecticides in paint materials

2.04 ACCESSORY MATERIALS

A. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

3.02 PREPARATION

A. General:
   1. Start of the surface preparation or paint materials application will be construed as applicator's acceptance of the surfaces as satisfactory for application of materials.
   2. Surface Appurtenances: Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
   3. Surfaces: Correct defects and clean surfaces of substances which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
   4. Marks: Seal with sealer compatible with primer and finish coats marks which may bleed through surface finishes.
   5. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
   6. Reduce the gloss of glossy surfaces to be painted.
   7. Fill nail holes, cracks, chips, spalls, and similar damaged areas to match adjacent undamaged areas.

B. Paint Removal:
   1. Remove flaking, cracking, blistering, peeling or otherwise deteriorated paint and paint failing adhesion testing, by scraping with hand scrapers.
   2. After scraping, remove large areas of paint on architectural details using sanders, heat guns or heat plates, or chemical paint removers. Do not use flame heat devices.
   3. When chemical strippers are used, neutralize substrate after stripping to a pH of 5 to 8.5.
   4. Remove paint to bare substrate or first sound paint layer.

5. Paint removal shall not damage or mar the substrate material.
6. After paint removal, featheredge and sand edges smooth of remaining chipped paint.

C. Previously Painted Surfaces:
1. Thoroughly remove all grease, dirt, dust or other foreign matter.
2. Remove coatings that are blistering, cracking, flaking, peeling, or otherwise deteriorating.
3. Roughen slick surfaces.
4. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.
5. Feather edge edges of chipped paint, and sand smooth.
6. Clean metal surfaces in accordance with SSPC requirements using solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting. Preparation of ferrous surfaces if not specified shall as recommended by coating manufacturer, but in no case less than SSPC-SP 3.
7. Chalk shall be removed so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.

D. Concrete Surfaces to be Painted:
1. Remove dirt, loose mortar, scale, salt or alkali powder, glaze, efflorescence, laitance, and other foreign matter.
2. Remove oil and grease with a solution of trisodium phosphate; rinse well and allow to dry.
3. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
4. Detergent wash surfaces to receive paint, in accordance with ASTM D4258. Rinse with water and allow to dry.
5. Allow surfaces to dry at lease 30 days before applying paint materials.
6. Fill concrete surface voids. Dried filler shall be uniform and free of pinholes. Do not apply filler over joint sealers.

E. Concrete Unit Masonry Surfaces to be Painted:
1. Remove dirt, efflorescence, laitance, and other foreign matter.
2. Remove oil and grease with a solution of trisodium phosphate; rinse well and allow to dry.
3. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
4. Allow surfaces to dry at lease 30 days before applying paint materials.

F. Stucco and Plaster Surfaces to be Painted:
1. Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces.
2. Wash and neutralize high alkali surfaces.
3. Allow to age minimum 30 days before painting.
4. Clean of all loose matter that may affect paint application.

G. Metal Piping: The semitransparent film applied at the mill to some piping and tubing is not considered a shop applied primer. Where indicated to be painted, overcoat with the specified ferrous metal primer.

H. Gypsum Board Surfaces to be Painted:
1. Fill minor defects with filler compound. Spot prime defects after repair.
2. Remove loose dust and dirt by brushing with a soft brush, rubbing with a cloth, or vacuum cleaning. A damp cloth may be used when water based paint materials are to be applied. Allow to dry.

I. Wood:
1. Wipe off dust and grit prior to priming.
2. Scrape and clean small, dry seasoned knots, then apply a thin coat of commercial knot sealer, before application of the priming coat.

3. Scrape off pitch on large, open, unseasoned knots and all other beads or streaks of pitch and sap. If the pitch is still soft, remove with mineral spirits or turpentine, and thinly coat the resinous area with knot sealer.
4. Back prime concealed surfaces before installation.
5. Sand between coats.
6. Set finishing nails, fill holes, and prime surface imperfections. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sand smooth.

J. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas and cotton.

3.03 APPLICATION

A. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

B. Thinning:
1. When thinning is required to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions.
2. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds.

C. Do not mix paint materials of different manufacturers.

D. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

E. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

G. Minimum Coating Thickness:
1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness as recommended by manufacturer. Provide total dry film thickness of the entire system as recommended by manufacturer.
2. Strip paint to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.
3. Apply each coat of paint so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. If application thickness or color and opacity of the paint do not achieve complete hiding, apply additional coat(s) to achieve complete hiding without change in contract price.

H. Apply two coats of primer or sealer to surfaces of wood doors, including top and bottom edges, which are cut.

I. Back prime and seal ends of interior panel backer boards specified to be finished.

3.04 INTERIOR WALL AND CEILING JOINTS

A. Sealant-Type Expansion Joints in Gypsum Wallboard:
1. Ensure that backer rod and joint sealant (specified in Division 07) are completed and cured prior to application of paint.

B. Control and Expansion Joints in Concrete and CMU:

1. Apply coatings to the joint face (approximately 1/2 inch (13 mm) deep) and allow to cure before installing backer and joint sealant specified in Division 07.

C. Fillet Joints between Hollow Metal Door Frames and Adjacent Walls (and similar locations):
1. Ensure that backer rod and joint sealant (specified in Division 07) are completed and cured prior to application of paint.

3.05 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to respective Sections in Divisions 21, 22, 23, and 26 for schedule of color coding of equipment, duct work, piping, and conduit.

B. Paint shop-primed equipment, where indicated.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.06 REPAIR AND RESTORATION

A. Reinstall electrical plates, hardware, light fixture trim, escutcheons, and fittings that were removed prior to preparing surfaces or finishing.

B. Restore to original condition surfaces damaged or marred by painting materials application.

C. Remove, refinish, or repaint work not complying with approved samples and other specified requirements.

3.07 PROTECTION AND CLEANING

A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.08 SCHEDULE - SURFACES TO BE FINISHED

A. Do Not Paint or Finish the Following Items:
1. Items fully factory-finished unless specifically noted.
2. UL, FMG, or other code required labels; fire rating labels; and equipment name, identification, performance rating, serial number and capacity labels.
3. Stainless steel items.

B. Paint the surfaces described in Schedules at the end of this Section and as follows:
1. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of permanently fixed equipment or furniture, paint surfaces behind permanently fixed equipment or furniture with primer only.
2. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
3. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
4. Paint both sides and edges of plywood panel backers for electrical and telephone equipment before installing equipment.

3.09 INTERIOR PRIMERS, SEALERS, AND FILLERS

A. Interior Acrylic Primer for Concrete and Plaster:
1. Benjamin Moore & Co.; 608 Ultra Spec Masonry Interior/Exterior 100% Acrylic Sealer (46 g/l).
2. PPG Paints; 4-603XI PERMA-CRETE Interior/Exterior Alkali Resistant Primer. (88 g/l)
3. The Sherwin-Williams Co.; A24W300 Loxon Concrete & Masonry Primer/Sealer. (< 50 g/l)

B. Interior Block Filler for Concrete Masonry Units:
1. Benjamin Moore & Co.; 571 Ultra Spec Hi-Build Masonry Block Filler. (45 g/l)
2. PPG Paints; 6-7 Speedhide INT/EXT Latex Masonry Block Filler. (18 g/l)
3. The Sherwin-Williams Co.; B25W25 PrepRite Acrylic Latex Block Filler. (42 g/l)

C. Interior Acrylic Primer for Gypsum Board:
   1. Benjamin Moore & Co.; N534 Ultra Spec 500 Interior Latex Primer. (0 g/l)
   2. PPG Paints; 6-4900XI Speedhide Zero VOC Interior Primer. (0 g/l)
   3. The Sherwin-Williams Co.; B28W02600 ProMar 200 Zero VOC Interior Latex Primer. (0 g/l)

D. Interior Acrylic Primer for Wood:
   1. Benjamin Moore & Co.; 046 Fresh Start High-Hiding All Purpose Primer. (44 g/l)
   2. PPG Paints; 17-921XI Seal-Grip Acrylic Latex Stain Blocking Primer. (84 g/l)
   3. The Sherwin-Williams Co.; PrepRite ProBlock Latex Primer, B51 Series. (96 g/l)

3.10 INTERIOR FINISH COATS

A. Flat Acrylic Finish Coats for Concrete, Plaster, Concrete Masonry Units, Gypsum Board, Wood:
   1. Benjamin Moore & Co.; N536 Ultra Spec 500 Interior Flat. (0 g/l)
   2. PPG Paints; 6-4110XI Speedhide Zero VOC Flat Interior Latex. (0 g/l)
   3. The Sherwin-Williams Co.; ProMar 200 Zero VOC Flat, B30-2600. (0 g/l)

B. Eggshell Acrylic Finish Coats for Concrete, Plaster, Concrete Masonry Units, Gypsum Board, Wood:
   1. Benjamin Moore & Co.; N538 Ultra Spec 500 Interior Eggshell. (0 g/l)
   2. PPG Paints; 6-4310XI Speedhide Zero VOC Interior Eggshell Latex. (0 g/l)
   3. The Sherwin-Williams Co.; ProMar 200 Zero VOC Eg-Shel, B20-2600. (0 g/l)

C. Semi-Gloss Acrylic Finish Coats for Concrete, Plaster, Concrete Masonry Units, Gypsum Board, Wood:
   1. Benjamin Moore & Co.; N539 Ultra Spec 500 Interior Semi-Gloss. (0 g/l)
   2. PPG Paints; 6-4510XO Speedhide Zero VOC Interior Semi-Gloss Latex. (0 g/l)
   3. The Sherwin Williams Co.; ProMar 200 Zero VOC Semi-Gloss B31-2600. (0 g/l)

3.11 PRIMER, INTERMEDIATE, AND TOP COAT COLORS

A. Except where coating materials cannot be tinted, tint each successive (primer, intermediate, top) coat of paint a sufficiently contrasting color to facilitate identification of complete coating coverage. The preceding coat may be in the same color family, but shall be noticeably different. Provide additional top coats without change in Contract Price if necessary to achieve complete hiding and uniform sheen.

B. Top coat colors are indicated on the drawings and schedules. For approval of actual colors, see sample and mock-up requirements specified above.

C. Top coat colors of manufacturers listed on the Finish Schedule (or elsewhere) indicate the required color, only, and do not indicate the required brand name product, which shall be as specified in above.

D. Top Coat Colors:
   1. Before submitting samples for approval and before purchasing project quantities of material, confirm with the Architect that colors have not changed based on awarded flooring, tile, and countertop finishes.
   2. Match the following colors:
      a. Paint Color 1 (PC1); Match Sherwin Williams Snowbound SW 7004 (field).
      b. Paint Color 2 (PC2); Architect/Designer to select color. (Accent)

3.12 PAINT SYSTEMS - INTERIOR

A. Concrete and Plaster:
   1. First Coat: Acrylic primer.
   2. Two Top Coats: Eggshell acrylic finish.

B. Concrete Masonry Units:
   1. First Coat: Acrylic Block Filler.
   2. Two Top Coats: Eggshell acrylic finish.

C. Gypsum Board:
   1. First Coat: Acrylic primer.
   2. Two Top Coats: Eggshell acrylic finish.

D. Gypsum Board Ceilings:
   1. First Coat: Acrylic primer.
   2. Two Top Coats: Flat latex paint finish.

E. Wood Trim, and Panel Backers, Painted:
   1. First Coat: Primer.
   2. Two Top Coats: Semi-gloss acrylic finish.

END OF SECTION

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Surface preparation.
   2. Application of primers, intermediate coats, and top coats for each coating system.

B. Coating Systems Include:

09 96 00.GFM	Gloss Fluoro-urethane Metal Finish
09 96 00.LUM	Low Gloss Urethane Metal Finish
09 96 00.LWE	Low Gloss Waterborne Epoxy

1.02 REFERENCES

A. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

B. SSPC-SP 11 - Power-Tool Cleaning to Bare Metal; 2020.

C. SSPC-SP 2 - Hand Tool Cleaning; 2018.

D. SSPC-SP 3 - Power Tool Cleaning; 2018.

E. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.03 SUBMITTALS

A. Product Data: Manufacturer's technical data sheets for each coating.
   1. Material analysis including vehicle type and percentage by weight and by volume of vehicle, resin, and pigment.
   2. Application instructions including mixing, surface preparation, compatible primers and topcoats, recommended wet and dry film thickness, recommended application methods.

B. Color and Texture Samples:
   1. Provide for each coating system, color, and texture and applied to representative substrate samples.
   2. Label each sample with coating name and color.
   3. Prepare samples to show bare, prepared surface and each successive coat.

1.04 QUALITY ASSURANCE

A. Installer: A company skilled in the application of special coatings whose installations have performed in a satisfactory manner under comparable conditions.

B. Coordination with Work Specified in Other Sections: Where primers will be applied in the shop, apply the primers listed in the schedule at the end of this section.
   1. Exception: Shop primed steel doors and frames shall receive fabricator's standard shop primer, followed by one full field coat of the primer specified in the schedule at the end of this section.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original containers bearing coating name and color, material composition data, date of manufacture, legal notices if applicable, and mixing, thinning, and application instructions.

B. Storage:
   1. Store materials in an orderly fashion and in clean, well-closed containers with labels intact.
   2. Maintain above 40 degrees F. Do not allow materials to freeze.

1.06 PROJECT CONDITIONS

A. Apply coatings only under the following environmental conditions:
   1. Air and surface temperatures are between 50 and 120 degrees F, or more restrictive when recommended by coatings manufacturer.

2. Surface temperature is at least 5 degrees F above dew point, or more restrictive when recommended by coatings manufacturer.
3. Relative humidity is less than 85 percent, or more restrictive when recommended by coatings manufacturer.

B. Do not apply coatings during inclement weather except within enclosed, conditioned spaces.

C. Provide temporary lighting to achieve a well-lit surface with a level of not less than 80 footcandles measured mid-height.

D. Provide continuous ventilation and heating to prevent accumulation of hazardous fumes, and maintain surface and ambient temperatures as specified above for 24 hours before, during, and for 48 hours after application of finishes (or longer if required to obtain full cure as indicated by manufacturer's instructions).

1.07 MAINTENANCE STOCK

A. At time of completing application, deliver stock of maintenance material to the Owner.

B. Furnish not less than one properly labeled and sealed gallon can of each type of finish coat of each color, taken from batch mix furnished for the work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all products of this section from a single manufacturer.

B. The brand-name products listed in the schedule at the end of this section and made by the following are the basis of the contract documents.
1. Tnemec Company, Inc.
2. Carboline.
3. PPG Architectural Finishes.

C. Provide the products listed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready for work in accordance with the contract documents and coating manufacturer's recommendations.

B. Prior to commencement of work, examine surfaces scheduled to be finished.
1. Report any unsatisfactory conditions in writing.
2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the applicator.
3. Beginning work on an area will be deemed acceptance of surfaces in that area.

3.02 PREPARATION

A. Do not apply coatings to labels that identify equipment, fire-resistance ratings, etc.

B. Remove hardware, switch and outlet plates, lighting fixtures, etc., before applying coatings. After application of coatings, reinstall removed items. Employ only skilled workmen for removal and replacement of such items.

C. Provide protection for non-removable items not scheduled for coating.

D. Protect surfaces not scheduled for coating. Clean, repair, or replace to the satisfaction of the Architect any surfaces inadvertently spattered or coated.

3.03 SURFACE PREPARATION

A. General: Clean and prepare surfaces as specified. Achieve the surface profile recommended by the coating manufacturer for optimum adhesion and proper appearance.

B. All Surfaces: Ensure surfaces are clean, dry and free of oil, grease and other contaminants.

C. Gypsum Wallboard: Latex-fill minor defects. Sand smooth when dry. Spot prime repair areas.

D. Concrete Masonry Units: Ensure that mortar joints are filled full of mortar and properly struck or tooled as required - no voids, gaps, or open joints allowed. Allow mortar to cure 28 days.
   1. Previously painted CMU: Remove existing coating by blast cleaning or other method of mechanical abrasion.

E. Concrete:
   1. Apply coatings to fully cured surfaces that are at least 28 days old.
   2. Perform any required surface repairs before applying coatings. Remove any fins or protrusions from surface. Patch any holes and cracks in an approved manner.
   3. Clean surface of all dirt, oil, wax, grease, or other contaminants before preparing surface profile. Use appropriate detergents and hot water. Thoroughly flush cleaning agents from surface.
   4. Vertical and overhead surfaces: Ensure that surfaces are clean and dry and free of contaminants.
   5. Allow substrate to dry thoroughly. Test for moisture in accordance with coating manufacturer's recommendations before applying coatings.

F. Ferrous Metal:
   1. Clean and prepare surface profile in accordance with applicable SSPC specifications:
      a. Interior metal: SSPC-SP 2 Hand Tool Cleaning, SSPC-SP 3 Power Tool Cleaning.
      b. Exterior metal: SSPC-SP 6 Commercial Blast Cleaning,
      c. Exterior metal (field touch-up): SSPC-SP 11 Power Tool Cleaning to Bare Metal.
      d. Previously painted metal: Remove existing coating by blast cleaning to SSPC-SP 6 Commercial Blast Cleaning.
   2. Before hand or power tool cleaning, remove visible oil, grease, soluble welding residue, and salts by SSPC-SP 1 Solvent Cleaning. After hand or power tool cleaning, reclean surfaces if necessary.
   3. Where commercial, near-white, or white metal abrasive blast cleaning is employed, apply first coat before rust-back occurs. Do not allow prepared surfaces to sit overnight without coating.
   4. Before touching up coatings damaged by handling or welding, re-prepare damaged surfaces to original specification.
      a. Where abrasive blast cleaning or pickling was used for original preparation, either blast clean to original specification or prepare surface to SSPC-SP 11 Power Tool Cleaning to Bare Metal.

3.04 MIXING AND THINNING

A. Remove and discard any skin formed on surface of coatings in containers. Discard any containers where skin comprises 2 percent or more of the remaining material.

B. Combine multi-component paints in quantities needed for use within the manufacturer's recommended pot life at the anticipated application temperatures. Discard remaining mixed material after pot life has expired.

C. Do not add thinner except as specifically recommended (not merely permitted) by the coating manufacturer for proper coating application under the circumstances prevailing at the project site when application equipment recommended by the coating manufacturer is employed. Use only the quantities and the types of thinner recommended.

D. Mix materials using mechanical mixers in accordance with coating manufacturer's instructions. Agitate mixed materials during application if recommended by manufacturer.

E. Strain pigmented coatings after mixing except where mechanical application equipment is provided with effective strainers.

3.05 APPLICATION

A. General:
   1. Metal Surfaces Exposed to View: Apply coatings using brush or spray, only. Roller application not permitted.
   2. Full, uniform coverage is required.
   3. Employ only application equipment that is clean, properly adjusted, in good working order, and of the type recommended by the coating manufacturer.
   4. Apply successive coats after adequate cure of the preceding coat and within the recommended recoating time.

B. Film Thickness: Apply each coat to achieve the dry film thickness (dft) in mils per coat indicated in the schedule at the end of this section. Application rates of excess thickness and fewer numbers of coats than specified will not be accepted.
   1. The dry film thicknesses shown in the schedule are per each coat.
   2. Where a thickness range is specified, the dry film thickness actually applied shall fall within the specified range when measured at any point, and the average dry film thickness actually applied to the entire surface shall be equal to the midpoint of the range specified plus or minus 10 percent.
   3. Where a single thickness value is specified, the dry film thickness actually applied, when measured at any point, shall be equal to the specified value plus or minus 10 percent.

C. Prime, First, or Bottom Coats:
   1. Concrete masonry units:
      a. A pinhole-free surface is required.
      b. Inspect the filled surface for pinholes and holidays and obtain approval before applying intermediate or top coats.
   2. Ferrous and Nonferrous Surfaces:
      a. Unless specifically indicated otherwise (in this section or in the respective metal section of the Specification), the first coat of material may be either shop or field applied.
      b. Shop or field applied coatings, including primers, intermediate coats, and finish coats, shall be as specified in this section. Unless specifically indicated otherwise, fabricator's standard shop coats will not be accepted, and if applied, shall be removed, the surface prepared anew, and the coatings specified herein applied.
      c. Where fabricator's standard shop primer is permitted to remain (e.g. steel doors and frames), apply one full field coat of the primer specified in this section.
      d. Ferrous metals that have not been shop primed shall be field primed promptly after arrival at the site or shall be stored away from the effects of weather.
   3. Either before or after applying prime coat but before applying successive coats, stripe paint edges, corners, mechanical fasteners, and welds using specified primer.
   4. Before applying successive coats, touch-up connections, fasteners, and damaged areas using specified primer.
   5. Where first coat shows signs of suction spots or poorly sealed areas, reapply first coat material to adequately seal surface before proceeding with intermediate and top coats.

D. Miscellaneous:
   1. Completed coatings shall be free of defects such as runs, sags, lap or brush marks, holidays, and skips.
   2. Apply coatings according to the schedule at the end of this section and as otherwise indicated. Coat all similar surfaces not specifically mentioned unless specifically exempted.
   3. Coat front and back of miscellaneous items such as covers, access panels, and grilles.
   4. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of permanently fixed equipment or furniture, paint surfaces behind permanently fixed equipment or furniture with primer only.

E. Apply coatings to match approved mock-ups.

F. Remove coatings not in compliance with this specification, reclean and re-prepare surfaces as specified, and apply coatings to comply with the contract documents.

3.06 JOINTS

A. Control and Expansion Joints in Floors, Walls, and Ceilings: Before installing backer rod and joint sealant specified in Division 07, apply coating to the joint face, approximately 1/2 inch deep, and allow to cure.

B. Fillet Joints between Hollow Metal Door Frames and Adjacent Walls (and similar locations): Apply coatings and allow to cure before installing joint sealant (and backers) specified in Division 07.

3.07 FIELD QUALITY CONTROL

A. Monitor coating thickness to ensure proper dry film thickness, complete coverage without skips, holidays, or pinholes and to obtain complete hiding of undercoats.

3.08 CLEANING

A. Clean work area on a daily basis; dispose of spent materials and empty containers. If requested, turn over to the Architect all empty coatings containers used during the course of each day.

B. Remove all trace of coatings inadvertently applied to adjacent surfaces not scheduled to be coated. Remove by appropriate methods that do not damage surfaces.

3.09 DEMONSTRATION AND INSTRUCTION

A. Instruct Owner's personnel in methods of touch up painting of interior epoxy coatings.

3.10 PROTECTION

A. Protect work against damage until fully cured. Provide signs identifying wet surfaces until surfaces are adequately cured.

B. Shortly before final completion of the project, examine surfaces for damage to coatings and restore coatings to new, undamaged condition.

1. Touch-up of minor damage will be acceptable where, in the opinion of the Architect, the result is not visibly different from surrounding surfaces. Recoat entire surface where result is different either in color, sheen, or texture.

3.11 PRIMER, INTERMEDIATE, AND TOP COAT COLORS

A. Except where coating materials cannot be tinted, tint each successive (primer, intermediate, top) coat of paint a sufficiently contrasting color to facilitate identification of complete coating coverage. The preceding coat may be in the same color family, but shall be noticeably different. Provide additional top coats without change in Contract Price if necessary to achieve complete hiding and uniform sheen.

B. Top coat colors are indicated on the drawings and schedules. For approval of actual colors, see sample and mock-up requirements specified above.

C. Top Coat Colors:

1. Before submitting samples for approval and before purchasing project quantities of material, confirm with the Architect that colors have not changed based on awarded flooring, tile, and countertop finishes.
2. Match the colors indicated on the Finish Schedule.
3. High Performance Coating 1 (HPC1); Match Sherwin Williams Snowbound SW 7004.

D. Top coat colors of manufacturers listed on the Finish Schedule (or elsewhere) indicate the required color, only, and do not indicate the required brand name product, which shall be as specified below.

3.12 SCHEDULE

A. FLUORO-URETHANE COATINGS ON METALS
   1. System Description:
      a. Epoxy primer.
      b. Epoxy or urethane intermediate coat.
      c. Fluoro-urethane polymer top coat.
   2. Tnemec:
      a. Primer: Series N69 Hi-Build Epoxoline II, DFT 2.0 to 3.0 mils. (285 g/l)
      b. Intermediate Coat: Series 73 Endura-Shield, DFT 2.0 to 3.0 mils. (378 g/l)
      c. Gloss Finish Coat: GFM material designation on Finish Schedule.
         1) Series 1070 Fluoronar, DFT 2.0 to 3.0 mils. (351 g/l)
   3. Carboline:
      a. Primer: Carboguard 893SG, DFT 3.0 to 5.0 mils. (336 g/l)
      b. Intermediate Coat: Carbothane 133MC, DFT 3.0 to 5.0 mils. (97 g/l)
      c. Gloss Finish Coat: GFM material designation on Finish Schedule.
         1) Carboxane 950 Gloss, DFT 2.0 to 3.0 mils. (420 g/l)
   4. PPG:
      a. Primer: Coraflon ADS Epoxy Primer ADS 573, DFT 2.0 to 3.0 mils. (227 g/l)
      b. Intermediate Coat: Pitthane High Build Urethane 95-8800, DFT 2.0 to 3.0 mils. (291.6 g/l)
      c. Gloss Finish Coat: GFM material designation on finish schedule.
         1) Coraflon ADS Intermix Gloss, DFT 1.5 to 2.0 mils.

B. URETHANE COATINGS ON METALS
   1. System Description:
      a. Epoxy primer.
      b. Epoxy intermediate.
      c. Urethane top coat.
   2. Tnemec:
      a. Primer: Series N69 Hi-Build Epoxoline II, DFT 2.0 to 3.0 mils. (285 g/l)
      b. Intermediate Coat: Series N69 Hi-Build Epoxoline II, DFT 2.0 to 3.0 mils. (285 g/l)
      c. Low Gloss (semi-gloss) Finish Coat: LUM material designation on Finish Schedule.
         1) Series 1075 Endura-Shield II; DFT 2.0 to 3.0 mils. (220 g/l)
   3. Carboline:
      a. Primer: Carboguard 893SG; DFT 3.0 to 5.0 mils. (336 g/l)
      b. Intermediate: Carboguard 893SG; DFT 3.0 to 5.0 mils. (336 g/l)
      c. Low Gloss (satin) Finish Coat: LUM material designation on Finish Schedule.
         1) Carbothane 133 MC; DFT 3.0 - 5.0 mils. (97 g/l)
   4. PPG:
      a. Primer: Pitt-Guard Rapid Coat Epoxy coating 95-245, DFT 2.0 3.0 mils. (263 g/l)
      b. Intermediate Coat: Pitt-Guard Rapid Coat Epoxy coating 95-245, DFT 2.0 3.0 mils. (263 g/l)
      c. Low Gloss (semi-gloss) Finish Coat: LUM material designation on finish schedule.
         1) Pitthane HB Semi-Gloss Urethane 95-8800, DFT 2.0 to 5.0 mils. (291.6 g/l)

C. WATER-BASED COATINGS ON INTERIOR WALLS AND CEILINGS.
   1. Apply coatings indicated for walls to all vertical surfaces in the space (e.g. columns, other vertical surfaces, etc.).
   2. Apply coatings indicated to ceilings to all overhead surfaces (e.g. soffits, fascia, beams, etc.).
   3. Apply coatings to miscellaneous surfaces in the space (e.g. steel doors and frames, steel piping and conduit, non-ferrous piping and conduit, PVC piping, ductwork, etc.).
   4. In the case of steel doors and frames, apply coatings to the "room-side" and to the "opposite-side" of the door and frame.

5. System(s):
    a. Gypsum Board Walls:
        1) Primer.
        2) Two top coats.
    b. CMU Walls:
        1) Block filler pin-hole-free.
        2) Two top coats
    c. Concrete Walls and Columns:
        1) Patch and surfacer.
        2) Two top coats.
    d. Gypsum Board Ceilings:
        1) Primer.
        2) Two top coats.
    e. Concrete Ceilings and Beams:
        1) Patch and surfacer.
        2) Two top coats.
    f. Structural Steel And Miscellaneous Steel:
        1) Steel primer.
        2) Two top coats.
6. Tnemec:
    a. Primers:
        1) Gypsum Wallboard Primer:
            (a) Series 151 Elasto-Grip FC, DFT 1.0 to 2.0 mils. (170 g/l)
        2) CMU Block Filler:
            (a) Apply not less than 2 coats Series 130, not to exceed 70 sf/gallon per coat, so as to achieve a pin-hole-free surface. (75 g/l)
        3) Concrete Patch and Surfacer:
            (a) Fill bugholes and patch other defects with Series 215 Surfacing Epoxy to achieve a smooth, monolithic surface. (75 g/l)
        4) Steel Primer:
            (a) Series L69 Hi-Build Epoxoline II, DFT 2.0 to 3.0 mils. (98 g/l)
    b. Top Coats:
        1) Low Gloss (Satin) Waterborne Epoxy: LWE material designation on Finish Schedule.
            (a) Series 113 H.B. Tneme-Tufcoat, DFT 4.0 to 6.0 mils. (228 g/l)
7. Carboline:
    a. Primers:
        1) Gypsum Wallboard Primer:
            (a) Carbocrylic 120, DFT 1.0 to 2.0 mils. (98 g/l)
        2) CMU Block Filler:
            (a) Apply not less than 2 coats Sanitile 600, not to exceed 78 sf/gallon per coat, so as to achieve a pin-hole-free surface. (216 g/l)
        3) Concrete Patch and Surfacer:
            (a) Fill bugholes and patch other defects with Carboguard 501 to achieve a smooth, monolithic surface. (0 g/l)
        4) Steel Primer:
            (a) Carboguard 890 VOC, DFT 4.0 to 6.0 mils. (100 g/l)
    b. Top Coats:
        1) Low Gloss (Semi-gloss) Waterborne Epoxy: LWE material designation on Finish Schedule.
            (a) Sanitile 255, DFT 2.0 to 3.0 mils. (156 g/l)
8. PPG:
    a. Primers:

1) Gypsum Wallboard Primer:
   (a) Seal Grip 100% Acrylic Universal Primer 17-921, DFT 1.2 to 1.5 mils. (84 g/l)
2) CMU Block Filler:
   (a) Apply not less than 2 coats Cementitious Epoxy Block Filler 95-217 Series, not to exceed 60 sf/gallon per coat, so as to achieve a pin-hole-free surface. (337 g/l)
3) Concrete Patch and Surfacer:
   (a) Fill bugholes and patch other defects with Megaseal CF Epoxy Filler 99-11401 to achieve a smooth, monolithic surface. (0 g/l)
4) Steel Primer:
   (a) PittGuard DTR Epoxy Coating 97-145, DFT 2.0 to 3.0 mils. (128 g/l)

b. Top Coats:
1) Low Gloss (Semi-gloss) Waterborne Epoxy: LWE material designation on Finish Schedule.
   (a) PPG Aquapon WB EP, DFT 2.0 to 4.0 mils. (126 g/l)

END OF SECTION

SECTION 10 11 01 - VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Factory Assembled Units:
   1. Glassboards.

1.02 REFERENCES

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

1.03 SUBMITTALS

A. Product Data: Provide manufacturer's data on products specified.
   1. Include cross-section details showing each type of product and components; trim, marker/chalk tray, face, core, backing materials and thickness, and key to elevations.

B. Manufacturer's printed installation instructions.

C. Maintenance Data: Manufacturer's cleaning and maintenance instructions covering both routine and long-term operations.

D. Shop Drawings:
   1. Include types of units provided, location within each room, and size of each unit.
   2. Include dimensioned elevation drawings of each board assembly indicating joint locations and type of joint where required, and board mounting distances from floors.
   3. Show locations and quantities of accessories.
   4. Show anchorage and installation details.

E. Warranty.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain visual display boards of each type from a single source.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Glassbaords:
   1. Clarus Glassboard LLC.: www.clarusglassboards.com
   2. Fulbright Glass Boards: www.fulbrightglassboards.com
   3. Dreamwalls: https://dreamwalls.com/markerboards/

2.03 WRITEABLE GLASS MATERIALS

A. Fixed, Glass, Dry-Erase Markerboards; 101101,GB1:
   1. Basis of Design: Clarus Glassboard LLC.
   2. Size: as noted on drawings
   3. Thickness: 1/4 inch
   4. Components (back to front):
      a. Glass: Tempered, PPG Starphire safety writing glass, non-staining surface, Clarus Opti-Clear
      b. Polish, polished eased edges on all four sides.
      c. Color: C101 Pure White
   5. Concealed: "Z" clip Glassboard to substrate.
   6. Shop fabricated

7. Meets BIFMA standards for horizontal pull test, vertical load test and vertical creep (long term static load) test.

2.04 ACCESSORIES

A. 10 1101.MH1; Marker Holder at all boards of all types.
   1. T Marker Tray holding markers and erasers.
      a. Dimensions: 2.75" Deep x 12" Wide
      b. Finish: Anodized Aluminum.
      c. Provide one marker holder for each board.
   2. Presentation Starter Kits: Provide one starter kit contianing 10 dry erase markers, two erasers, 10 cleaning towels, and one 8 ounce bottle liquid surface cleaning solution for each room or area installed with porcelain board or glassboard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on drawings.

B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as instructed by manufacturer.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure units level and plumb.

3.03 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

END OF SECTION

SECTION 10 11 47 - TACKABLE WALLCOVERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient cork tackable wallcovering.

B. Accessories.

1.02 SUBMITTALS

A. Product data.

B. Samples: 6 x 9 inch (150 x 230 mm) samples of each tackable material required.

1.03 QUALITY ASSURANCE

A. Applicator: Installation by skilled commercial wallcovering applicators with no less than three years of documented experience installing dry erase wallcovering of the types and extent required.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original factory wrappings and containers, clearly labeled with manufacturer, brand name, and fire hazard classification.

B. Store materials in original, undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within the storage area at not less than 70 deg F (21 deg C) during the period materials are stored.

1.05 PROJECT CONDITIONS

A. Maintain ambient temperature within the building at not less than 68 deg F (20 deg C) for a minimum of 72 hours prior to beginning of installation.

B. Do not install tackable wallcovering until the space is enclosed and weatherproof.

C. Do not install tackable wallcovering until temperature is stabilized and permanent lighting is in place.

1.06 MAINTENANCE

A. Maintenance instructions: Include precautions against cleaning materials and methods that may be detrimental to finishes and performance.

PART 2 - PRODUCTS

2.01 TACKABLE WALLCOVERING

A. Tackable Wallcovering: Uni-color, linoleum resilient homogeneous tackable surface consisting of linseed oil, granulated cork, rosin binders and dry pigments calendared onto natural burlap backing. Color shall extend through thickness of material.

1. Claridge Products; Claridge Cork.
   a. 1109 Buff
2. Forbo; Bulletin Board.
   a. 2187
3. Koroseal Interior Products; Walltalkers Tac Wall; www.koroseal.com.
   a. Color: Sandalwood

2.02 ACCESSORIES

A. Aluminum J Trim, clear anodized aluminum.

B. Adhesives: Heavy-duty clear premixed vinyl adhesive or clay based adhesive.

C. Substrate Primer/Sealer: White pigmented acrylic base primer/sealer specifically formulated for use with vinyl wallcoverings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions in which tackable wallcoverings will be installed.
   1. Complete finishing operations, including painting, before beginning installation of tackable wallcovering materials.
   2. Wall surfaces to receive wallcovering materials shall be dry and free from dirt, grease, loose paint, and scale.
   3. Do not proceed with installations until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Remove hardware, accessories, plates and similar items to allow tackable wallcovering to be installed.

B. Prime substrate as recommended by manufacturer.

3.03 INSTALLATION

A. Comply with manufacturer’s installation instructions.

B. Apply adhesive with 1/16 inch (1.5 mm) trowel to area to receive sheet.

C. Work from top to bottom then side to side. Roll sheet firmly into adhesive for positive contact and to remove air bubbles.

D. Remove adhesive residue immediately.

E. Scribe, cut, and fit material to butt tightly to adjacent surfaces, built-in casework, and permanent fixtures and pipes.

F. Lap and double cut seams.

G. Butt joint.

H. Install tray and trim in accordance with manufacturer's instructions.

3.04 CLEAN-UP

A. Upon completion of installation, remove exposed adhesive immediately using a natural sponge and a warm, mild soap solution. Rinse thoroughly with water and dry with clean towel prior to using.

END OF SECTION

SECTION 10 14 23 - PANEL SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Panel signage.

1.02 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.

C. Shop Drawings:
   1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
   2. Schedule: Provide information sufficient to completely define each panel sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
      a. When room numbers to appear on signs differ from those on drawings, include the room number on schedule.
      b. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
      c. Submit for approval by Owner through Architect prior to fabrication.

D. Selection Samples: Where colors, materials, and finishes are not specified, submit two sets of color selection charts or chips.

E. Verification Samples: Submit samples showing colors, materials, and finishes specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Panel Signage:
   1. APCO; www.apcosigns.com
   2. Best Sign Systems, Inc; www.bestsigns.com
   3. FASTSIGNS Internations, Inc; www.fastsigns.com

2.02 REGULATORY REQUIREMENTS

A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.03 PANEL SIGNAGE

A. Panel Signage:
   1. General: Comply with UNC Signage Standards.
   2. Application: Room and door signs.
   3. Description: Flat signs with engraved panel media, tactile characters.
   4. Sign Size: 4 inches by 6 inches (100 mm by 152 mm).
   5. Sign Edges: Squared.
   6. Corners: Squared.
   7. Color and Font, unless otherwise indicated:

a. Character Font: as indicated in UNC signage standards.
b. Character Case: Upper and lower case (title case).
c. Background Color: Pantone color to be selected by Owner.
d. Character Color: Contrasting color.

8. Profile: Flat panel in aluminum frame.
   a. Frame Finish: Black anodized.
9. Tactile Letters: Raised 1/32 inch minimum.

END OF SECTION

SECTION 10 21 13 - TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Toilet compartments.

B. Urinal screens.

1.02 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.04 SUBMITTALS

A. Product Data: Provide data on panel construction, hardware, and accessories.

B. Samples: Submit two samples of partition panels, 8 x 8 inch (203 x 203 mm) in size illustrating panel finish, color, and sheen.

C. Manufacturer's Installation Instructions: Indicate perimeter conditions requiring special attention.

D. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Solid Plastic Toilet Compartments:
   1. Ampco Products, Inc: www.ampco.com.
   2. Metpar Corp: www.metpar.com.
   3. Scranton Products (Santanta/Comtec/Capital); www.scrantonproducts, com.

2.02 GENERAL REQUIREMENTS

A. Manufacturer shall ensure that accessible units comply with ADA Standards in every respect.

B. Privacy Joinery: Provide full privacy (zero sight through joint) at door jambs and panel joints.

2.03 SOLID PLASTIC COMPONENTS

A. Toilet Compartment Suspension: Floor-mounted, headrail-braced.

B. Solid molded high density polyethylene (HDPE) plastic panels, doors, and pilasters.
   1. Solid color throughout.

C. Color: to be selected by architect/desinger from manufacturers full offerings..

D. Door and Panel Dimensions:
   1. Thickness: 1 inch (25 mm).
   2. Door Width: 24 inch (610 mm).
   3. Door Width for Handicapped Use: 36 inch (914 mm) wide, out-swinging.
   4. Height: 72 inch (1828.8 mm); locate bottom edge 10 inches (254 mm) above finish floor.
   5. Thickness of Pilasters: 1 inch (25 mm).

E. Urinal Screens: Wall mounted with two panel brackets.

F. Brackets: Polished stainless steel.

2.04 ACCESSORIES

A. Support Steel: Design and provide concealed support steel necessary for anchoring compartments and screens.

1. Design Loads: Design each support and attachment to resist imposed dead load plus each of the following, applied individually:
   a. Concentrated live load of 300 lbs (136 kg) applied vertically (downward) at any point on the panel.
   b. Concentrated live load of 200 lbs (91 kg) applied horizontally at any point on the panel.

B. Pilaster Shoes: Formed chromed steel with polished finish, 3 inch (76 mm) high, concealing floor and ceiling fastenings.
   1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
   2. Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.

C. Head Rails: Hollow chrome-plated steel tube, 1 x 1-5/8 inch (25 x 41 mm) size, with anti-grip strips and cast socket wall brackets.

D. Attachments, Screws, and Bolts: Stainless steel, tamper proof.

E. Hardware: Polished chrome plated non-ferrous cast metal:
   1. Continuous hinges.
   2. Thumb turn or sliding door latch with exterior emergency access feature.
   3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
   4. Coat hook with rubber bumper; one per compartment, mounted on door.
   5. Provide door pull for outswinging doors.
   6. Provide complete ADA compliant hardware for accessible units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify conditions before starting work.

B. Verify that field measurements are as indicated.

C. Verify correct spacing of and between plumbing fixtures.

D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.

B. Maintain 3/8 to 1/2 inch (10 to 13 mm) space between wall and panels and between wall and end pilasters.

C. Attach panel brackets securely to walls using anchor devices.

D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES

A. Maximum Variation From True Position: 1/4 inch (6 mm).

B. Maximum Variation From Plumb: 1/8 inch (3 mm).

3.04 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch (5 mm).

B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.

C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.

B. Changing stations.

C. Installation of OFCI and CFCI accessories.

1.02 ABBREVIATIONS AND ACRONYMS

A. PETG: Polyethylene Terephthalate Glycol.

B. PPE: Personal Protective Equipment.

C. OFCI - Owner Furnishes and Contractor Installs.

D. CFCI - Contractor Furnishes and Contractor Installs.

1.03 REFERENCE STANDARDS

A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2015a (Reapproved 2019).

B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

C. ASTM C1036 - Standard Specification for Flat Glass; 2021.

D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.

E. ASTM D5047 - Standard Specification for Polyethylene Terephthalate Film and Sheeting; 2017.

F. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use; 2004, with Editorial Revision (2016).

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS

A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

B. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS (OFCI)

A. Owner will furnish the following types of products for installation by Contractor:
   1. Toilet paper dispensers.
   2. Seat cover dispensers.
   3. Sanitary disposal units.
   4. Soap dispensers.
   5. Paper tower dispensers.

2.02 MANUFACTURERS

A. Commercial Toilet, Shower, and Bath Accessories:
   1. American Specialties, Inc: www.americanspecialties.com/#sle.
   2. Bobrick Washroom Equipment, Inc: www.bobrick.com/#sle.
   3. Bradley Corporation: www.bradleycorp.com/#sle.

2.03 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   1. Grind welded joints smooth.
   2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.

B. Keys: Provide 4 keys for each accessory to Owner; master key lockable accessories.

C. Stainless Steel Sheet: ASTM A666, Type 304.

D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

E. PETG Plastic Sheet: ASTM D5047.

F. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.

G. Adhesive: Two component epoxy type, waterproof.

H. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof.

2.04 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.05 COMMERCIAL TOILET ACCESSORIES

A. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick tempered safety glass; ASTM C1048.
   1. Size: As indicated on drawings.
   2. Frame: 0.05 inch (1.3 mm)channel shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
   3. Backing: Full-mirror sized, minimum 0.03 inch (0.8 mm) galvanized steel sheet and nonabsorptive filler material.

B. Grab Bars: Stainless steel, smooth surface.
   1. Heavy Duty Grab Bars: Floor supports are acceptable if necessary to achieve load rating.
      a. Push/Pull Point Load: Minimum 1000 pound-force (4448.2 N), minimum.
      b. Dimensions: 1-1/2 inch (38 mm) outside diameter, minimum 0.125 inch (3.17 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.
      c. Length and Configuration: As indicated on drawings.

2.06 DIAPER CHANGING STATIONS

A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
   1. Material: Polyethylene.
   2. Mounting: Surface.
   3. Minimum Rated Load: 250 pounds (113.4 kg).

B. Adult Changing Station: Wall-mounted
   1. Material:
   2. Mounting: Surface
   3. Minimum rated load:

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

END OF SECTION

SECTION 10 44 00 - FIRES EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

1.02 REFERENCES

A. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 PERFORMANCE REQUIREMENTS

A. Provide extinguishers classified and labeled by testing firm acceptable to the Fire Marshall for the purpose specified and indicated.

1.04 SUBMITTALS

A. Product Data.

B. Maintenance Data: Include test, refill, or recharge schedules and re-certification requirements.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Fire Extinguishers, Cabinets and Accessories:
   1. JL Industries, Inc.: www.jlindustries.com.
   2. Larsen's Manufacturing Co.: www.larsensmfg.com.
   3. Potter-Roemer: www.potterroemer.com.

2.03 FIRE EXTINGUISHERS

A. Provide units labeled by UL (DIR).

B. Dry Chemical Multi-Purpose Type: Steel cylinder.
   1. Size: 4A60BC.
   2. Diameter: 5 inches (127 mm).
   3. Finish: Powder coat, red color.

2.04 CABINETS FOR DRY TYPE MULTI-PURPOSE FIRE EXTINGUISHERS

A. Style: Vertical Duo.

B. Trim: Flat, 1 inch (25 mm)-wide face.

C. Recessed Cabinet (non-fire-rated box):
   1. Exterior nominal dimensions of 9 to 10-1/2 inches (229 to 267 mm) wide x 24 inches (610 mm) high x 6 inches (152 mm) deep.
   2. Finish: Stainless Steel.
      a. J.L.; Cosmopolitan 1035.
      b. Larsen's; Architectural SS2409-R2.
      c. Potter-Roemer; Alta SS 7060 DV.

D. Semi-recessed (non-fire-rated box):
   1. Exterior nominal dimensions of 12 inches (305 mm) wide x 27 inches (686 mm) high x 6 inches (152 mm) deep.
   2. Finish: Stainless Steel.
      a. J.L.; Cosmopolitan 1037 (3 inches (76 mm) projection).
      b. Larsen's; Architectural SS2409-6R (2-1/2 inch (64 mm) projection).
      c. Potter-Roemer; Alta SS 7062 DV (2 inch (51 mm) projection).

E. Door: 0.036 inch (0.9 mm) thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with continuous piano hinge. Provide nylon catch.

F. Door Glazing: Tempered Glass, clear, 1/8 inch (3 mm) thick float. Set in resilient channel gasket glazing.

G. Finish of Cabinet Interior: White enamel.

H. Cabinet Signage: FIRE EXTINGUISHER in black vertical letters parallel to vertical-duo window.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level, 34 inches (864 mm) from finished floor to inside bottom of cabinet.

C. Secure rigidly in place.

END OF SECTION

SECTION 10 51 29 - PHENOLIC LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Phenolic lockers.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking and nailers.

1.03 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.

C. Shop Drawings: Indicate locker plan layout, numbering plan.

D. Samples: Submit two samples 3 by 6 inches (75 by 150 mm) in size, of color selected.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Phenolic Lockers:
   1. Hollman; Locker Model E :https://hollman.com/
   2. Columbia Lockers, a division of PSiSC; Phenolic Lockers: www.psisc.com/#sle.
   3. List Industries, Inc; ____: www.listindustries.com/#sle.

2.02 LOCKER APPLICATIONS

A. Student Lockers: Phenolic lockers, wall mounted with matching closed base.
   1. Width: 15 inches (381 mm).
   2. Depth: 18 inches (457 mm).
   3. Height: 72 inches (1830 mm).
   4. Locker Configuration: Three tier.
   5. Fittings:
      a. Hooks: One double prong.
   6. Locking: Built-in digital keypad locks.

2.03 PHENOLIC LOCKERS

A. Lockers: Factory assembled, made of phenolic core panels with mortise and tenon joints and stainless steel mechanical joint fasteners; fully finished inside and out; each locker capable of standing alone.
   1. Doors: Full overlay, covering full width and height of locker body; square edges.
   2. Panel Core Exposed at Edges: Machine polished, without chips or tool marks; square edge unless otherwise indicated.
   3. Where locker ends or sides are exposed, finish the same as fronts or provide extra panels to match fronts.
   4. Door Color: As selected by Architect.
   5. Body Color: Manufacturer's standard white or light color.
   6. Fasteners for Accessories and Locking Mechanisms: Tamperproof type.

B. Component Thicknesses:

1. Doors: 1/2 inch (13 mm) minimum thickness.
2. Locker Body:
   a. Tops, bottoms, and shelves 3/8 inch (10 mm); sides and backs 5/16 inch (8 mm); minimum.

C. Phenolic Core Panels: Nonporous phenolic resin and paper core formed under high pressure, with natural colored finished edges, integral melamine surface, matte finish, and uniform surface appearance; glued laminated panels not acceptable.
   1. Surface Burning Characteristics: Flame spread index of 75 or less, and smoke developed index of 450 or less; when tested in accordance with ASTM E84.

D. Coat Hooks: Stainless steel or reinforced nylon; attached with tamperproof screws.

E. Number Plates: Manufacturer's standard, minimum 4-digit, permanently attached with adhesive; may be field installed.

F. Built-In Digital Keypad Locks:
   1. Built-In Digital Keypad Lock: Battery-powered lock with alphanumeric keypad for 4-digit access code; optional access with programming, manager bypass, or user key.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared bases are in correct position and configuration.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers plumb and square.

C. Bolt adjoining locker units together to provide rigid installation.

D. Install accessories.

E. Replace components that do not operate smoothly.

3.03 CLEANING

A. Clean locker interiors and exterior surfaces.

END OF SECTION

SECTION 11 81 29 - FACILITY FALL PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended access anchorage system for all portions of main building facade. Provide independent anchorage for access and for fall arrest.

B. Personal fall arrest anchorage system for portions of roof where parapet does not extend to 42 inches (1067 mm) tall.

C. Systems that provide a safe working access for future roof-top maintenance activities.

D. Systems that provide a safe working access for future window washing activities.

E. Systems that provide a safe working access for future inspection and light maintenance (hand-held tools) of facades.

1.02 SECTION DOES NOT INCLUDE

A. Systems for other locations in or around the building such as loading docks or building interiors.

B. Systems for future operations within locations protected by with permanent guardrails or parapets meeting criteria established by OSHA and authorities having jurisdiction.

1.03 DESIGN REQUIREMENTS

A. The architectural drawings illustrate a design concept for guidance of the system design engineer (Qualified Person) as to the Owner's intentions regarding working access. The architectural drawings illustrate a concept, only, and are not exhaustive; Contractor is responsible for providing a final design in compliance with OSHA requirements within the Contract Price without change order on account of variances, if any, between Contractor's final design and the concept drawings. The system design engineer (Qualified Person) will be solely responsible for the design and certification of the system.

1.04 REFERENCES

A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

B. 29 CFR 1910, Subpart D - Walking-Working Surfaces, 1910.21-1910.30; Current Edition.

C. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).

D. ASTM A747/747M - Standard Specification for Steel Castings, Stainless, Precipitation Hardening; 2018.

E. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2022).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate design and installation of fall protection system with existing and new steel structural framing and roof deck construction.
   1. Coordinate layout and installation of work of this Section with interfacing and adjoining work and other Sections affecting or affected by work of this Section for proper sequencing of each installation.
   2. Instruct other trades of proper location and position.

1.06 SUBMITTALS

A. Product data.

B. Qualifications:
   1. Manufacturer and installer insurance certificates.
   2. Welder certification.

C. Shop drawings: Sealed by the system design engineer.
   1. System layout.

2. Show rated and ultimate loads imposed by each component that connects to the building structure.
3. Identify materials and illustrate details of attachment to building structure.
4. Identify shop and field welds with AWS welding symbols.

D. Project Closeout Documentation:
1. Project Record Documents (as-builts) bearing the system design engineer's seal.
2. Detailed user instructions for delivery to the Owner:
a. Manufacturer's name, address, and telephone number.
b. Manufacturer's user instructions for each part, with model number.
c. Statement of manufacturer's intended use and purpose of each system.
d. Description of proper methods and limitations on use of each system.
e. Printed information or illustrations of fixed equipment markings.
f. Description of detailed inspection and recertification procedures for each system.
g. Criteria for failing inspections and determining unusable equipment.
h. Procedures for maintenance and repair requirements.
i. Identification of who is authorized to make adjustments and and repairs to equipment.
j. Appropriate warnings regarding altering, misusing, and limitations of equipment.
3. Approved copies of shop drawings.
4. Results of load testing at the rated load.
5. System design engineer's certification: Documentation that system was installed in accordance with manufacturer's instructions, and has been inspected and anchorages certified.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide products of a manufacturer who has specialized in products specified in this section for not less than 10 years. Carry products and completed operations liability insurance in an amount of not less than $5,000,000.

B. Installer Qualifications: Trained or qualified by manufacturer. Carry products and completed operations liability insurance in an amount of not less than $5,000,000.

C. Welding: Comply with AWS D1.1/D1.1M. Employ only welders certified per AWS procedures.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Provide products of one of the following:
1. Diversified Fall Protection Inc.; 350 Green Oaks Pkwy, Holly Springs, NC 27540; www.fallprotect.com.
2. Pro-Bel; 421 Guilford Avenue, P.O. Box #556; Chambersburg, PA 17201; www.pro-bel.ca.
3. Miller Fall Protection; 1345 15th St., Franklin, PA 16323; millerfallprotection.com.

2.03 SYSTEM DESIGN REQUIREMENTS

A. Engineering Design / System Design Engineer:
1. Design systems and manufactured units under the direct supervision of a Professional Engineer registered in the State in which the Project is located.
2. Engineer is a Qualified Person as defined by OSHA with extensive experience and expertise in design of fall protection.
3. Verify that building structural components to which system components will be anchored are adequate to resist the imposed loads. Design component anchorage within the allowable limits of the existing structure; where necessary provide additional reinforcing to distribute imposed loads within allowable limits of the existing structure.

B. Design systems and manufactured units in compliance with applicable codes and regulations, including:
   1. OSHA 29 CFR Subpart M 1926.501-503 Fall Protection.
   2. North Carolina Department of Labor's Occupational Safety & Health Administration regulations, including 13 NCAC 07F.0101and 13 NCAC 07F.0201.
   3. North Carolina Building Code.
   4. University of North Carolina at Chapel Hill Department of Facilities Services Permanent Fall Protection Guidelines.

C. Employ systems and components thereof in continuity with other fall protection systems extant throughout the campus; utilize compatible components.

D. Waterproofing:
   1. Design each point of connection to the building structure to provide permanent watertight protection without the need for maintenance or relying on recaulking.
   2. Allow each point of connection through the roof covering or through wall cladding for subsequent repair, removal, and reinstallation of roofing or wall cladding components without affecting the integrity of the connecting element.

E. Fall or Impact Loads During Normal Use:
   1. Design each component so as to sustain the full design load during use without damage, deformation, or the need to replace or renew components or parts thereof, providing however that after an impact event such components are to be immediately removed from service and reinspected and recertified before returning such components to use.

2.04 MANUFACTURED UNITS

A. Roof-top Anchors.

B. Horizontal Lifelines and connection devices.

C. Davit Bases.

D. Davits.

E. Personal Equipment:
   1. Provide 3 each harnesses, shock-absorbing lanyards, and clips.

2.05 HORIZONTAL LIFELINE SYSTEM

A. Horizontal Cable Lifeline System: Hands-free fixed cable type for [rooftop] [wall] installation. Design system for [travel restraint] [fall arrest] purposes and install to allow users to walk uninterrupted the entire length of the system and provide secure anchorage to arrest a fall. System shall allow attachment at any point along the cable and enable freedom of movement along the cable as it passes by components.

B. Basis of Design System: RoofSafe Cable System by 3M as Distributed by Diversified Fall Protection.
   1. Cable: ASTM A492 316 stainless steel wire rope, 7 x 7 type; 5/16 inch (7.94 mm) diameter
   2. Fixed End Anchorage: Permanently swaged 316 stainless steel terminations.
   3. Tensioner: Manufacturer's standard, with visual tension indicator.
   4. Intermediate Guide: 8mm (5/16”) Type 316 Stainless Steel, electropolished.
   5. 90 and 45 Degree Corners: 316 Stainless Steel, electropolished. Achieve other angles using Variable Guide.
   6. Variable Guide: 316 Stainless Steel, electropolished.
   7. Swage Toggles: 316 Stainless Steel.
   8. Attachment Device with Carabiner: ASTM A747/747M stainless steel casting, electropolished and numbered.

C. Tension Absorber End Anchorage: 316 stainless steel tensioner with 180 pounds (82 kg) visual tension indicator.

D. Intermediate Brackets: 5/16 inch (8 mm) 316 stainless steel, electropolished.

E. Corner and Curve Transitions: 316 stainless steel, electropolished.

F. Horizontal Lifeline Energy Absorber: Installed inline at cable terminations as designated by Qualified Fall Protection Engineer. 316 stainless steel.

G. Attachment Traveler Device: 316 stainless steel casting, electropolished and serial numbered; with carabiner designed for attachment to cable at any point and to slide along cable.

H. Roof-Mounted Force Management Anchorage: Energy-absorbing force management type as specified above. Equip each anchorage with loop and pin for cable attachment.

2.06 MATERIALS

A. Materials exposed to the weather: Stainless steel.

2.07 IDENTIFYING DEVICES

A. Provide at each roof access point a Roof Plan, laminated in plastic and affixed within a picture frame, mounted to the wall. Show:
   1. Fall protection system locations.
   2. Anchor load ratings.
   3. Number of authorized simultaneous users of each system or component.
   4. Date of initial certification.
   5. Name of professional engineer who designed the system and certified anchorages, and the design engineer's seal.

B. Provide at each roof access point the following information, laminated in plastic and affixed within a picture frame, mounted to the wall:
   1. Emergency contact information (obtain from the Owner).
   2. Emergency rescue procedures.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install systems in accordance with manufacturer's instructions and approved shop drawings.

3.02 LOAD TESTS

A. Test anchorage assemblies and fall arrest equipment at the rated load.

B. Load test as prescribed, defined, and certified by the system design engineer.

C. Determine elastic deformation of the test anchorage or anchorage connector in accordance with calculations performed and certified by the system design engineer.

3.03 INSTRUCTION

A. Provide on-site instruction and training of Owner's personnel in proper use of systems.

END OF SECTION

SECTION 12 24 13 - WINDOW SHADE SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manually-operated window shades and accessories.

1.02 SUBMITTALS

A. Product Data: Manufacturer's catalog data, product descriptions, installation instructions, detail sheets, and specifications for each type system specified.
   1. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, and instructions for operating hardware and controls.

B. Samples for Verification: Shade fabric sample and paint finish as selected.

C. Shop Drawings: Show dimensions and interface with other products.
   1. Room schedule including field-verified dimensions of each opening to receive window shade system.
   2. Use same room designations as indicated on Drawings. Key to typical mounting details.
   3. Indicate model number, operator, fabric selection, and mounting type.
   4. Indicate control type and provide zone schedule if necessary.

D. Closeout Submittals:
   1. Warranty.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience installing products comparable to those specified in this section.

1.04 WARRANTY

A. Roller shade hardware, chain and shade fabric: Manufacturer's standard warranty.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for project when occupied for its intended use.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in manufacturer's original cartons.

B. Individually package and mark shades with room number and opening number.

C. Inspect the materials upon delivery to assure that specified products have been received.

D. Store and handle shades to prevent damage to fabrics, finishes, and operators prior to installation.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Refer to Section 01 60 00 - Product Requirements .

2.02 MANUFACTURERS

A. Mechoshade Systems LLC: www.mechoshade.com.

B. Hunter Douglas: www.hunterdouglasarchitectural.com.

C. Springs Window Fashions; SWF Contract: www.SWFcontract.com.

2.03 SHADE SYSTEMS

A. System 1: Manual window shade, Fabric 1, regular roll direction, mounted outside window frame, chain operated control.

B. System 2: Manual window shade, Fabric 2, regular roll direction, mounted outside window frame, with side and sill channels for blackout, chain operated control.

2.04 FABRIC

A. Fabric 1: Solar Control.
   1. Mechoshade, EcoVeil:
      a. Openness factor: 1%
      b. Pattern: Series 1750
      c. Color: to be selected by architect/designer from manufacturers full offerings.
   2. Hunter Douglas, GreenScreen:
      a. Openness factor: 1%
      b. Pattern: Revive Series
      c. Color: to be selected by architect/designer from manufacturers full offerings.
   3. SWF Contract, Eternity:
      a. Openness factor: 1%
      b. Pattern: E100 Series
      c. Color: to be selected by architect/designer from manufacturers full offerings.

B. Fabric 2: Room Darkening.
   1. Mechoshade, Equinox Blackout:
      a. Openness factor: 0%
      b. Pattern: 0100 Series
      c. Color: to be selected by architect/designer from manufacturers full offerings.
   2. Hunter Douglas, SheerWeave:
      a. Openness factor: 0%
      b. Pattern: 7000 Series
      c. Color: to be selected by architect/designer from manufacturers full offerings.
   3. SWF Contract, Blackout Series:
      a. Openness factor: 0%
      b. Pattern: Parallel
      c. Color: to be selected by architect/designer from manufacturers full offerings.

2.05 MANUALLY OPERATED WINDOW SHADE SYSTEM

A. Location: Refer to drawings for distinction on where solar and blackout shades are to be located.

B. Products:
   1. Mechoshade; Mecho/5 system.
   2. Hunter Douglas Architectural: RB 500+.
   3. Springs Window Fashions; SWF Contract; Pro Series.

C. Chain Operation: Bi-directional wrap spring clutch shall allow for shade to stop and hold at any position.

D. Chain Operator Position: Right-hand side, unless otherwise noted on drawings.

E. Bead Chain: No. 10 stainless steel.

F. Clutch mechanism: Fabricated from high carbon steel.
   1. Components fabricated from styrene based plastics, polyester or reinforced polyester are not acceptable.

2.06 SHADE COMPONENTS

A. Rollers:
   1. Shade roller tube shall be extruded aluminum of diameter and wall thickness required to support shade fabric. Maximum allowable deflection L/700.
   2. Rollers shall be easy to remove from support brackets.

B. Mounting Brackets: Stamped steel, custom fabricated as required for mounting style indicated.

C. Hembar: Exposed.

1. Shape: Manufacturer's standard.
2. Finish: Clear anodized aluminum.

2.07 ACCESSORIES

A. Finish for accessories, unless otherwise noted: Clear anodized aluminum.

B. Pocket: Extruded aluminum shall conceal mounting hardware, roller tube, and fabric rolled on tube.

C. Fascia/Pocket End Caps: Provide end caps where mounting conditions expose outside of roller shade brackets.

2.08 SHADE FABRICATION

A. Shade fabric shall hang flat without buckling or distortion and in the same direction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Correct unsatisfactory substrates before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Verify that blocking and framing necessary to carry shade assembly hardware is properly installed and secure.

3.03 INSTALLATION

A. Install window shade systems level, plumb, square and true according to manufacturer's written instructions and these specifications.

B. Adjust and balance roller shades to operate smoothly, safely and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

D. Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.04 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION

SECTION 12 36 00 - COUNTERTOPS, VERTICAL MILLWORK SURROUND, AND WINDOW STOOLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Solid Surface Countertops.

B. Solid Surface Countertops with Undermount Sinks.

C. Soild Surface Vertical Surrounds.

D. Alternate A1: Wood Window Stools.

1.02 REFERENCES

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

B. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.

C. PS 1 - Structural Plywood; 2009 (Revised 2019).

1.03 SUBMITTALS

A. Product Data: Provide data on specified component products.

B. Samples: Submit two samples of countertop, 2 x 2 x 1/2 inches (51 x 51 x 13 mm) in size, illustrating color, texture, and finish.

C. Shop Drawings: Indicate dimensions, thicknesses, backsplashes, sidesplashes, required clearances, materials, colors, finishes, field jointing, adjacent construction, design load parameters, methods of support, and anchorages.
   1. Indicate integration of plumbing components.

D. Manufacturer's Installation Instructions.
   1. Indicate preparation of opening required.

E. Maintenance Data: Indicate list of approved cleaning materials and procedures required; list of substances that are harmful to component materials.
   1. Include instructions for stain removal, surface and gloss restoration.

1.04 QUALITY ASSURANCE

A. Fabricator: Manufacturer's authorized fabricator.

1.05 PROJECT CONDITIONS

A. Verify that field measurements are as indicated.

B. Sequence Work to permit installation of plumbing rough-in.

PART 2 PRODUCTS

2.01 SOLID SURFACE MATERIAL

A. Color selections listed are based on grouped specification sections Basis of Design. Refer to Section 01 30 00 for grouped specifications. If another acceptable manufacturer within the listing is provided in lieu of Basis of Design this could prompt color selections being required to be reviewed and reselected with the same style, line, and series of listed manufacturer product.

B. Manufacturers:
   1. BASIS OF DESIGN: Solid Surface 1 (123600.SS1): DuPont Corian; https://www.corian.com (break room)
      a. Color: Limestone Prima
      b. Contact: William Lee, william.david.lee@dupont.com
      c. Other acceptable Manufacturers:
         1) LG Hi-Macs USA. https://www.lxhausys.com/us

(a) Color: Marmo Nebbia
(b) Contact: Michelle Allen, 513.214.9939, mallen@lxhausys.com
2) Wilsonart International. www.wilsonart.com
(a) Color: Beige Travertine
(b) Contact: April Brickle, brickla@wilsonart.com, 540.537.3431 c

2. BASIS OF DESIGN: Solid surface 2 (123600.SS2): DuPont Corian; https://www.corian.com (restroom)
a. Color: White Onyx
b. Contact: William Lee, william.david.lee@dupont.com
c. Other acceptable Manufacturers:
1) LG Hi-Macs USA. https://www.lxhausys.com/us
(a) Color: Aurora Pavia M603
(b) Contact: Michelle Allen, 513.214.9939, mallen@lxhausys.com
2) Wilsonart International. www.wilsonart.com
(a) Color: Quiet Swirl
(b) Contact: April Brickle, brickla@wilsonart.com, 540.537.3431 c
3. BASIS OF DESIGN: Solid Surface 3 (123600.SS3): DuPont Corian; https://www.corian.com (bench vertical surround)
a. Color: Deep Mink
b. Contact: Barbara Davis, bdavis@hllmark.com
c. Other acceptable Manufacturers:
1) Staron: https://www.staron.com/intro/us
(a) Color: Sanded Chestnut SC457
(b) Contact: Jackie Johnson, jjohnson@rugbyabp.com, 704.604.0136 o
2) Wilsonart International. www.wilsonart.com
(a) Color: Hot Stone 9201GS
(b) Contact: April Brickle, brickla@wilsonart.com, 540.537.3431 c

C. Solid Surface Sheet: Non-porous blend of polyester or acrylic alloys and fillers.
1. Comply with ISFA 2-01.
2. Capable of being worked and repaired using standard woodworking tools.
3. No surface coating. Color and pattern consistent throughout thickness.

D. Flat Sheet Thickness: 1/2 inch (13 mm) sheet thickness. Provide total thickness indicated on drawings.

E. Joint Adhesive: Manufacturer's standard adhesive to create invisible, nonporous joints with a chemical bond.

F. Sinks: Refer to plumbing specifications for sinks.

G. Bowl Mounting Hardware: Manufacturer's approved bowl clips, brass inserts, and fasteners for attachment of undermount bowls.

H. Supporting Substrate: Plywood, PS 1 Exterior Type, AC veneer grade, minimum 5-ply; not less than 3/4 inch (19 mm) thick.
1. Join lengths using metal splines.
2. Provide cutouts in plywood for heat release as required by manufacturer.

2.02 WOOD SURFACE MATERIAL

A. Wood Surface:
1. Hardwood Lumber: Maple species, plain sawn, maximum moisture content of 6 percent; with vertical grain, of quality suitable for transparent finish.

2.03 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.

B. Edge Detail: As indicated on drawings.

C. Provide holes and cutouts for plumbing accessories as indicated on shop drawings.

D. Solid Surface:
   1. Form joints between components using manufacturer's standard joint adhesive. Joints shall be invisible in appearance and without voids. Attach 4 inches (102 mm) wide reinforcing strip under joints as required by manufacturer.
   2. Rout and finish component edges to a smooth, uniform finish.
   3. Rout cutouts then sand edges smooth.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates. Identify conditions detrimental to proper or timely installation. Do not commence installation until conditions have been corrected.

3.02 INSTALLATION

A. Install components plumb, level true and straight in accordance with approved shop drawings, project installation details and manufacturer's printed instructions. Shim as necessary using concealed shims.

B. Provide inconspicuous joints in finished work.

3.03 INSTALLATION - COUNTERTOPS

A. Attach top securely to base unit or support brackets.

B. Provide side splashes where countertops abut vertical walls.

C. Provide back splashes where countertops abut vertical walls.

D. For solid surface backsplashes, provide hard seamed coved backsplash with 1/4 inch (6 mm) radius.

E. Seal between wall and back and side splashes with sealant specified in Section 07 92 00 - Joint Sealants.

F. Adhere undermount sinks to countertop using manufacturer's recommended adhesive and mounting hardware.

G. Coordinate plumbing installation with Division 23.

3.04 INSTALLATION - WINDOW STOOLS

A. Install window stools full length of window, set securely into place using only concealed fasteners and manufacturer's approved adhesive.

B. Provide minimum 1/8 inch (3 mm) expansion gaps on each side of window stools, sealed with manufacturer's approved sealant.

C. Remove excessive adhesive and sealants.

3.05 CLEANING

A. Clean fabrication surfaces in accordance with manufacturer's instructions.

3.06 PROTECTION OF FINISHED WORK

A. Protect surfaces from damage until date of Final Acceptance. Replace damaged components that cannot be repaired to Architect's satisfaction.

B. Review maintenance procedures with Owner's representative upon completion of project.

END OF SECTION

SECTION 14 24 00 - ELEVATOR CAB FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Alternate A2: Provide and install new elevator cab interior finishes: wall panels and flooring.

1.02 RELATED REQUIREMENTS

A. Section 09 65 00 - Resilient Flooring_____.

B. Section 09 68 16 - Sheet Carpeting: Floor finish in car.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

A. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
   1. Cab panels.
   2. Floor material layout.

B. Samples: Submit samples illustrating finishes in the form of product cut sheets and physical samples.

PART 2 PRODUCTS

2.01 MATERIALS

A. Carpet Flooring: See Section 09 68 16, Type CT4.

2.02 CAR AND HOISTWAY ENTRANCES

2.03 CAR EQUIPMENT AND MATERIALS

A. Elevator Car, No. 1:
   1. Flooring: Carpet Tile 4 (09 6813.CT4).
   2. Side Walls: Plastic laminate on plywood. Match 06 4100.PL1 as specified in Section 06 4100 Architectural Wood Casework & Upholstered Bench Seating.
   3. Rear Wall: Plastic laminate on plywood. Match 06 4100.PL1 as specified in Section 06 4100 Architectural Wood Casework & Upholstered Bench Seating.
   4. Existing Handrail to remain. Protect during construction and tighten any loose attachments.
   5. Ceiling:
      a. Existing ceiling & lights to remain. Secure existing lights, tighten trim around lights and protect during construction.

PART 3 EXECUTION

3.01 CLEANING

A. Clean surfaces and components in accordance with manufacturers written instructions.

3.02 PROTECTION

A. Do not permit construction traffic within car after cleaning.

END OF SECTION

SECTION 14 24 00 - ELEVATOR CAB FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Alternate A2: Provide and install new elevator cab interior finishes: wall panels and flooring.

1.02 RELATED REQUIREMENTS

A. Section 09 65 00 - Resilient Flooring_____.

B. Section 09 68 16 - Sheet Carpeting: Floor finish in car.

1.03 REFERENCE STANDARDS

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A. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
   1. Cab panels.
   2. Floor material layout.

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PART 2 PRODUCTS

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   3. Rear Wall: Plastic laminate on plywood. Match 06 4100.PL1 as specified in Section 06 4100 Architectural Wood Casework & Upholstered Bench Seating.
   4. Existing Handrail to remain. Protect during construction and tighten any loose attachments.
   5. Ceiling:
      a. Existing ceiling & lights to remain. Secure existing lights, tighten trim around lights and protect during construction.

PART 3 EXECUTION

3.01 CLEANING

A. Clean surfaces and components in accordance with manufacturers written instructions.

3.02 PROTECTION

A. Do not permit construction traffic within car after cleaning.

END OF SECTION

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Manufacturers: Subject to compliance with requirements, undefined:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.02 STACK-SLEEVE FITTINGS

A. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

B. Plastic or rubber waterstop collar with center opening to match piping OD.

2.05 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.06 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
      c. Polymeric Systems, Inc.
      d. Sherwin-Williams Company (The).
      e. Sika Corporation.
      f. The Dow Chemical Company.
      g. Tremco Incorporated.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal around the outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant, to seal the space around outside of sleeve-seal fittings.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.06 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls below Grade:
      a. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system Steel pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   2. Interior Partitions:
      a. Piping Smaller Than NPS 6 : Steel pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.03 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BrassCraft Manufacturing Co.; a Masco company.
   2. Dearborn Brass.
   3. Jones Stephens Corp.
   4. Keeney Manufacturing Company (The).
   5. Mid-America Fittings, Inc.
   6. ProFlo; a Ferguson Enterprises, Inc. brand.

2.02 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.03 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
      b. Insulated Piping: One-piece steel with finish.

c. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
d. Insulated Piping: One-piece cast brass with finish.
e. Insulated Piping: One-piece stamped steel with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
g. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
h. Bare Piping in Unfinished Service Spaces: One-piece stamped steel with polished, chrome-plated finish.
i. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
j. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece stamped steel with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping : One-piece, floor plate.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.02 DEFINITIONS

A. NRS: Nonrising stem.

B. OS&Y: Outside screw and yoke.

C. SBR: Styrene-butadiene rubber.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
1. Fire Main Equipment: HAMV - Main Level.
a. Indicator Posts, Gate Valve: HCBZ - Level 1.
b. Ball Valves, System Control: HLUG - Level 3.
c. Butterfly Valves: HLXS - Level 3.
d. Check Valves: HMER - Level 3.
e. Gate Valves: HMRZ - Level 3.
2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.
a. Valves, Trim and Drain: VQGU - Level 1.

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NFPA Compliance for valves:
1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.

E. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.03 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Ames Fire & Waterworks; A WATTS Brand.
2. NIBCO INC.
3. Victaulic Company.

B. Description:
1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.04 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ALEUM USA.
2. Globe Fire Sprinkler Corporation.
3. Milwaukee Valve Company.

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze with EPDM coating.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.

9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.05 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ALEUM USA.
2. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve Company; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
7. Victaulic Company.
8. Zurn Industries, LLC.

B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear.
8. Body Design: Lug or wafer.

2.06 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ALEUM USA.
2. Ames Fire & Waterworks; A WATTS Brand.
3. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
4. FEBCO; A WATTS Brand.
5. Fire Protection Products, Inc.
6. Globe Fire Sprinkler Corporation.
7. Kennedy Valve Company; a division of McWane, Inc.
8. Matco-Norca.
9. Mueller Co.
10. NIBCO INC.
11. Reliable Automatic Sprinkler Co., Inc. (The).
12. Shurjoint; a part of Aalberts Integrated piping Systems.
13. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
14. United Brass Works, Inc.
15. Venus Fire Protection Ltd.
16. Victaulic Company.
17. Viking Corporation.
18. WATTS.
19. Wilson & Cousins Inc.
20. Zurn Industries, LLC.

B. Description:
1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.

5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.07 BRONZE OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Milwaukee Valve Company.
2. NIBCO INC.
3. United Brass Works, Inc.
4. Zurn Industries, LLC.

B. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.08 IRON OS&Y GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Hammond Valve.
4. Kennedy Valve Company; a division of McWane, Inc.
5. Mueller Co.
6. NIBCO INC.
7. Victaulic Company.
8. WATTS.
9. Zurn Industries, LLC.

B. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. End Connections: Flanged Grooved Threaded.

2.09 NRS GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.
6. Victaulic Company.

7. Zurn Industries, LLC.

B. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.10 INDICATOR POSTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. American Cast Iron Pipe Company.
2. Clow Valve Company; a subsidiary of McWane, Inc.
3. Kennedy Valve Company; a division of McWane, Inc.
4. Mueller Co.
5. NIBCO INC.

B. Description:
1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Upright.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench.

2.11 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Fire Protection Products, Inc.
c. Fire-End & Croker Corporation.
d. Flowserve Corporation.
e. FNW; Ferguson Enterprises, Inc.
f. Jomar Valve.
g. KITZ Corporation.
h. Legend Valve & Fitting, Inc.
i. Metso Automation USA Inc.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Potter Roemer LLC; a Division of Morris Group International.
m. Red-White Valve Corp.
n. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
o. Victaulic Company.
p. WATTS.
q. Zurn Industries, LLC.
2. Description:
a. Pressure Rating: 175 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.

d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 INSTALLATION, GENERAL

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
1. Section 21 12 00 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
2. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
3. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
4. Section 33 14 15 "Site Water Distribution Piping" for application of valves in fire-suppression water-service piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.

C. Install double-check valve assembly in each fire-protection water-supply connection.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

SECTION 21 05 29 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Equipment supports.

B. Related Requirements:
1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers.
2. Equipment supports.

1.04 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 13.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cooper B-line; brand of Eaton, Electrical Sector.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.

d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated or Stainless steel.
3. Outdoor Applications: Stainless steel.

2.05 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.06 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 250 lb.

3.02 INSTALLATION OF HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. MSS SP-58, Type 39 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. MSS SP-58, Type 40 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.03 INSTALLATION OF EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

A. Touchup:
   1. Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting." Section 09 91 23 "Interior Painting."

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

H. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Comply with NFPA requirements.

K. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

L. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

M. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 210533 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes heat tracing for fire-suppression piping with the following electric heating cables:
   1. Self-regulating, parallel resistance.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.06 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chromalox, Inc.
   2. RAYCHEM; brand of nVent Electrical plc.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. *Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.*

I. Capacities and Characteristics:
   1. Maximum Heat Output: 10 W/ft.
   2. Piping Diameter: 6".
   3. Number of Parallel Cables: 2.
   4. Electrical Characteristics for Single-Circuit Connection:

      a. Volts: 208.
      b. Phase: 1.
      c. Hertz: 60.
      d. Full-Load Amperes: 19.
      e. Minimum Circuit Ampacity: 25.
      f. Maximum Overcurrent Protection: 40.

2.02 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install electric heating cable where indicated and according to NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion joints according to manufacturer's written instructions; use cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables according to IEEE 515.1.

E. Install insulation over piping with electric cables according to Section 210700 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.03 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system according to NFPA 13. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems."

3.04 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing.
   3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning tape
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Brass, 0.032 inch stainless steel, 0.025 inch aluminum, 0.032 inch anodized aluminum, 0.032 inch thick, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.

j. Seton Identification Products; a Brady Corporation company.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.02 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. National Marker Company.
5. Seton Identification Products; a Brady Corporation company.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 2 inches.

2.03 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.04 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.04 inch stainless steel, 0.024 inch aluminum, 0.031 inch or anodized aluminum, 0.031 inch thick, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire link chain beaded chain or S-hook.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.

2.05 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Champion America.
4. Craftmark Pipe Markers.
5. emedco.
6. Kolbi Pipe Marker Co.
7. LEM Products Inc.
8. Marking Services Inc.
9. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of fire-suppression equipment.

B. Sign and Label Colors:
1. White letters on an ANSI Z535.1 safety-red background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.04 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.05 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit a view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Fire-Suppression Pipe Label Color Schedule:
1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

3.06 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-suppression system valve tags.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
   1. Valve-Tag Size and Shape:
      a. Fire-Suppression Standpipe: 2 inches, round.
      b. Wet-Pipe Sprinkler System: 2 inches, round.
      c. Dry-Pipe Sprinkler System: 2 inches, round.
   2. Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background.

3.07 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION

SECTION 21 07 00 - FIRE-SUPPRESSION SYSTEMS INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating the following fire protection piping services:
   1. Outdoor piping.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   3. Detail attachment and covering of heat tracing inside insulation.
   4. Detail insulation application at pipe expansion joints for each type of insulation.
   5. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   6. Detail removable insulation at piping specialties.
   7. Detail application of field-applied jackets.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program, certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size, as well as ASTM standard designation, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 21 05 29 "Hangers and Supports for Fire-Suppression Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and with equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities

having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

A. Comply with requirements in "Diesel Engine Exhaust Insulation Schedule"; "Equipment Insulation Schedule"; "Piping Insulation Schedule, General"; "Indoor Piping Insulation Schedule"; and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.

1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Owens Corning.
2. Block Insulation: Type I.
3. Preformed Pipe Insulation, Type II, Class 2: With factory-applied PSK.
4. Special-Shaped Insulation: Type III.
5. Board Insulation: Type IV.
6. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
7. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA.
   b. Armacell LLC.
   c. K-Flex USA.

I. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For equipment applications, provide insulation. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Certainteed; SAINT-GOBAIN.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Knauf Insulation.
   d. Manson Insulation Inc.
   e. Owens Corning.

J. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature of up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Knauf Insulation.
      c. Manson Insulation Inc.
      d. Owens Corning.
   2. Preformed Pipe Insulation: Type I, Grade A with factory-applied PSK jacket.
   3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.
   2. Semirigid board material with factory-applied PSK jacket.
   3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Phenolic: Prefabricated pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Kingspan Tarec Industrial Insulation NV.
      c. Polyguard Products, Inc.
      d. Resolco Inc.
   2. Prefabricated Pipe Insulation: Type III with factory-applied PSK jacket.
   3. Prefabricated shapes in accordance with ASTM C450 and ASTM C585.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. Polyisocyanurate: Prefabricated, rigid cellular polyisocyanurate material intended for use as thermal insulation. Comply with ASTM C591.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Duna USA Inc.
      b. Dyplast Products.
      c. Johns Manville; a Berkshire Hathaway company.
   2. Prefabricated insulation.
   3. Type I or Type IV, except thermal conductivity (k-value) does not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
   4. Flame-spread index is 25 or less and smoke-developed index is 50 or less for thickness up to 1.5 inch as tested in accordance with ASTM E84.
   5. Fabricate shapes in accordance with ASTM C450 and ASTM C585.
   6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials, self-seal.

2.03 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
   4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving, with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
   5. PSK Jacket: Aluminum-foil-fiberglass-reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.04 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Industrial Adhesives and Tapes Division.
      b. Avery Dennison Corporation, Specialty Tapes Division.
      c. Ideal Tape Co., Inc., an American Biltrite Company.
      d. Knauf Insulation.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Industrial Adhesives and Tapes Division.
      b. Avery Dennison Corporation, Specialty Tapes Division.
      c. Ideal Tape Co., Inc., an American Biltrite Company.
      d. Knauf Insulation.
      e. Venture Tape.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.
   3. Adhesion: 64 ounces force/inch in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Industrial Adhesives and Tapes Division.
      b. Avery Dennison Corporation, Specialty Tapes Division.
      c. Ideal Tape Co., Inc., an American Biltrite Company.
      d. Knauf Insulation.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   4. Adhesion: 100 ounces force/inch in width.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with epoxy primer 5 mils thick and epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended in writing by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended in writing by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install

insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using prefabricated fitting insulation or mitered or routed fittings made from same material and density as adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with prefabricated fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for pressure gauges, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure single-layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as straight segments of pipe insulation when available.
2. When prefabricated insulation sections of insulation are unavailable, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install calcium silicate pipe insulation, quads, hex sections, or beveled lag segments, adhered together, to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.07 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as straight segments of pipe insulation when available.
2. When preformed sections of insulation are unavailable, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.08 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.

3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated sections of same material as straight segments of pipe insulation when available.
2. When prefabricated sections are unavailable, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:
1. Secure single-layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

D. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated insulation sections, or mitered or routed fittings, of same material as straight segments of pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed insulation sections of same material as straight segments of pipe insulation.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation is tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation. Where voids are difficult to fill with block insulation, fill voids with a fibrous insulation material suitable for specific operating temperature.

C. Insulation Installation on Fittings and Elbows:
1. Install prefabricated sections of same material as straight segments of pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.12 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive, or via self-seal mechanism to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.15 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Indoor fire-suppression piping.
2. Underground piping.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Outdoor Fire-Suppression Piping Filled with Water:
1. All Pipe Sizes: Insulation is one of the following:
a. Cellular Glass: 2 inches thick.
b. Flexible Elastomeric: 2 inches thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
d. Phenolic: 2 inches thick.
e. Polyisocyanurate: 2 inches thick.

f. Polyolefin: 2 inches thick.

END OF SECTION

SECTION 21 12 00 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Manual control stations.
6. Pressure gauges.

B. Related Requirements:
1. Section 10 44 13 "Fire Protection Cabinets" for hose-connection and hose-station cabinets.
2. Section 21 05 23 "General-Duty Valves for Water-Based Fire-Suppression Piping."
3. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire-department connections.
4. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
5. Section 21 13 16 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
6. Section 28 46 21.11 "Addressable Fire-Alarm Systems" for connections to alarm devices.

1.02 DEFINITIONS

A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at maximum working pressure of 175 psig.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire-suppression standpipes.
1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, drawn to scale, or BIM model, showing the items described in this Section and coordinated with all building trades.

B. Qualification Data: For Installer.

C. Approved Standpipe Drawings: Working plans, prepared in accordance with NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Fire-hydrant flow test report.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTIONS

A. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections and has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.

2.02 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14-2013.

C. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.

D. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
1. Minimum residual pressure at each hose-connection outlet is as follows:
a. NPS 2-1/2 Hose Connections: 100 psig.

2.03 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

2.04 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

A. Schedule 40: ASTM A53/A53M, Type E, Grade B, with factory- or field-formed ends to accommodate joining method.

B. Schedule 10: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Uncoated, Steel Couplings: ASTM A865/A865M, threaded.

D. Ductile-Iron Unions: UL 860.

E. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

F. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. CPS Products, Inc.
c. National Fittings, Inc.
d. Shurjoint; a part of Aalberts Integrated piping Systems.
e. Smith-Cooper International.
f. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
g. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A47/A47M malleable-iron casting or ASTM A536 ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.05 PIPING JOINING MATERIALS

A. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.

2.06 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brooks Equipment Co., Inc.
b. Elkhart Brass Mfg. Co., Inc.
c. Potter Roemer LLC; a Division of Morris Group International.
d. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
e. Zurn Industries, LLC.
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300-psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2, as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle.
9. Finish: Rough brass or bronze.

2.07 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Electrically Operated Alarm Bell:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Notifier; Honeywell International, Inc.
b. Potter Electric Signal Company, LLC.
c. Siemens Industry, Inc., Building Technologies Division.
d. Simplex; brand of Johnson Controls International plc, Building Solutions North America.
e. Edwards; Carrier Global Corporation.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ADT Security Services, Inc.
b. McDonnell & Miller.
c. Potter Electric Signal Company, LLC.
d. System Sensor.
e. Viking Corporation.
f. WATTS.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kennedy Valve Company; a division of McWane, Inc.
      b. Potter Electric Signal Company, LLC.
      c. System Sensor.
   2. Standard: UL 346.
   3. Type: Electrically supervised.
   4. Components: Single-pole, double-throw switch with normally closed contacts.
   5. Design: Signals that controlled valve is in other than fully open position.

E. Indicator-Post Supervisory Switches:
   1. Standard: UL 346.
   2. Type: Electrically supervised.
   3. Components: Single-pole, double-throw switch with normally closed contacts.
   4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.08 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK, Inc.
   2. Ashcroft Inc.
   3. Brecco Corporation.
   4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gauge Range: 0 to 250-psig minimum.

E. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 33 14 15 "Site Water Distribution Piping."

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Section 33 14 15 "Site Water Distribution Piping."

3.04 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.

C. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install drain valves on standpipes. Extend drain piping to outside of building.

E. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.

F. Install alarm devices in piping systems.

G. Install hangers and supports for standpipe system piping in accordance with NFPA 14. Comply with requirements in NFPA 13 for hanger materials.

H. Install pressure gauges on riser or feed main and at top of each standpipe. Include pressure gauges with connection of not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

I. Drain dry-type standpipe system piping.

J. Fill wet-type standpipe system piping with water.

K. Connect compressed-air or nitrogen supply to dry-pipe sprinkler piping.

L. Connect air compressor to the following piping and wiring:
   1. Pressure gauges and controls.
   2. Electrical power system.
   3. Fire-alarm devices, including low-pressure alarm.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.05 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Brazed Joints: Join copper tube and fittings according to Copper Development Association's "Copper Tube Handbook," "Brazed Joints" chapter.

L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.06 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with NFPA 14, authorities having jurisdiction and manufacturer's instructions.

B. Install listed fire-protection supervised-open shutoff valves, located to control sources of water supply, except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.07 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.

D. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 10 44 13 "Fire Protection Cabinets."

3.08 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping in accordance with NFPA 14 requirements.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Flush, test, and inspect standpipe systems in accordance with NFPA 14, "System Acceptance" chapter.
   4. Energize circuits to electrical equipment and devices.
   5. Start and run air compressors.
   6. Coordinate with fire-alarm tests. Operate as required.
   7. Coordinate with fire-pump tests. Operate as required.
   8. Verify that equipment hose threads are same as local fire-department equipment.

C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 and smaller, shall be the following:
   1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8, shall be the following:
   1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, dry-type fire-suppression standpipe piping, NPS 5 to NPS 8, shall be the following:
   1. Schedule 40, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

END OF SECTION

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Steel pipe and fittings.
2. Specialty valves.
3. Air vent.
4. Sprinkler piping specialties.
5. Sprinklers.
6. Alarm devices.
7. Pressure gauges.

B. Related Requirements:
1. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 23 05 23 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.
3. Section 33 14 15 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

1.02 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For qualified Installer.

C. Design Data:
1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:
1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

2.02 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Black-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

D. Uncoated-Steel Couplings: ASTM A865/A865M, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
   1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8-inch thick ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.
      a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
      b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
   2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
   1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. CPS Products, Inc.
c. National Fittings, Inc.
d. Shurjoint; a part of Aalberts Integrated piping Systems.
e. Smith-Cooper International.
f. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
g. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Painted Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory."

B. Pressure Rating:
1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.04 AIR VENT

A. Automatic Air Vent:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing, Inc.
b. CLA-VAL.
c. Engineered Corrosion Solutions.
d. Metraflex Company (The).
e. Val-Matic Valve & Manufacturing Corp.
2. Description: Automatic air vent that automatically vents trapped air without human intervention.
3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.
4. Vents oxygen continuously from system.
5. Float valve to prevent water discharge.
6. Minimum Water Working Pressure Rating: 175 psig.

2.05 SPRINKLER PIPING SPECIALTIES

A. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing, Inc.
b. Reliable Automatic Sprinkler Co., Inc. (The).
c. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

B. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AGF Manufacturing, Inc.
b. Triple R Specialty.
c. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
d. Victaulic Company.
e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Flexible Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ALEUM USA.
b. FlexHead Industries, Inc.
c. Gateway Tubing, Inc.
d. Victaulic Company.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.06 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
4. Venus Fire Protection Ltd.
5. Victaulic Company.
6. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:
   1. Nonresidential Applications: UL 199.
   2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: bronze and painted.

F. Special Coatings: corrosion-resistant paint.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, one piece, flat.

H. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

2.07 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Notification Appliances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Notifier; Honeywell International, Inc.
      b. Potter Electric Signal Company, LLC.
   2. Electric Bell:
      a. Standard: UL 464.
      b. Type: Vibrating, metal alarm bell.
      c. Size: 6-inch minimum- diameter.
      d. Voltage: 24 V dc.
      e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.

C. Water-Flow Indicators:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. ADT Security Services, Inc.
      b. McDonnell & Miller.
      c. Potter Electric Signal Company, LLC.
      d. System Sensor.
      e. Viking Corporation.
      f. WATTS.
   2. Standard: UL 346.
   3. Water-Flow Detector: Electrically supervised.
   4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   5. Type: Paddle operated.
   6. Pressure Rating: 250 psig.
   7. Design Installation: Horizontal or vertical.

D. Pressure Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Barksdale, Inc.
      b. Detroit Switch, Inc.
      c. Potter Electric Signal Company, LLC.
      d. System Sensor.
      e. Tyco Fire Products: brand of Johnson Controls International plc, Building Solutions North America.
      f. United Electric Controls Co.
      g. Viking Corporation.
   2. Standard: UL 346.
   3. Type: Electrically supervised water-flow switch with retard feature.
   4. Components: Single-pole, double-throw switch with normally closed contacts.
   5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Kennedy Valve Company; a division of McWane, Inc.
      b. Potter Electric Signal Company, LLC.
      c. System Sensor.
   2. Standard: UL 346.
   3. Type: Electrically supervised.
   4. Components: Single-pole, double-throw switch with normally closed contacts.
   5. Design: Signals that controlled valve is in other than fully open position.
   6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.08 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AGF Manufacturing, Inc.
   2. AMETEK, Inc.
   3. Ashcroft Inc.
   4. Brecco Corporation.
   5. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gauge Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 33 14 15 "Site Water Distribution Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 33 14 15 "Site Water Distribution Piping."

3.03 INSTALLATION OF PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
   2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal and install where they are not subject to freezing.

M. Fill sprinkler system piping with water.

N. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 21 05 33 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 21 07 00 "Fire-Suppression Systems Insulation."

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.04 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.05 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 for supports.

3.06 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.

E. Air Vent:
1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
3. Pipe from outlet of air vent to drain.

3.07 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.08 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.09 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be the following:
1. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.

2. Rooms with Suspended Ceilings: Recessed sprinklers Concealed sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 13 16 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Steel pipe and fittings.
2. Specialty valves.
3. Dry-sprinkler system nitrogen generator with purge/vent.
4. Sprinkler piping specialties.
5. Sprinklers.
6. Alarm devices.
7. Pressure gauges.

B. Related Requirements:
1. Section 21 11 19 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 21 05 23 "Fire Protection Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.02 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For dry-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.

B. Qualification Data: For qualified Installer.

C. Design Data:
1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Fire-hydrant flow test report.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dry-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.07 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTIONS

A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air or nitrogen. Opening of sprinklers releases compressed air or nitrogen and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

2.02 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

D. Sprinkler system design shall be approved by authorities having jurisdiction.
   1. Margin of Safety for Available Water Flow and Pressure: measured hydraulic information shall be adjusted 10 psi less static, 10 psi less residual, and 10% less flow prior to performing hydraulic calculations. Hydraulica calculations shall include losses through water-service piping, valves, and backflow preventers.
   2. Sprinkler Occupancy Hazard Classifications:
      a. Crawlspace Areas: Light Hazard.
   3. Minimum Density for Automatic-Sprinkler Piping Design:
      a. Light Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   4. Maximum protection area per sprinkler according to UL listing.
   5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
      a. Ordinary-Hazard Occupancies: 100 gpm for 30 minutes.

2.03 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

C. Galvanized-Steel Couplings: ASTM A865/A865M, threaded.

D. Ductile-Iron Unions: UL 860.

E. Grooved-Joint, Steel-Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. CPS Products, Inc.
c. National Fittings, Inc.
d. Shurjoint; a part of Aalberts Integrated piping Systems.
e. Smith-Cooper International.
f. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
g. Victaulic Company.
2. Pressure Rating: 175-psig minimum.
3. Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.04 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory."

B. Pressure Rating:
1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Dry-Pipe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Globe Fire Sprinkler Corporation.
b. Reliable Automatic Sprinkler Co., Inc. (The).
c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
d. Venus Fire Protection Ltd.
e. Victaulic Company.
f. Viking Corporation.
2. Standard: UL 260.
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
5. Air-Pressure Maintenance Device:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) General Air Products, Inc.
2) Globe Fire Sprinkler Corporation.
3) Reliable Automatic Sprinkler Co., Inc. (The).
4) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
5) Venus Fire Protection Ltd.
6) Victaulic Company.
7) Viking Corporation.
b. Standard: UL 260.
c. Type: Automatic device to maintain minimum air pressure in piping.

d. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig outlet pressure.

6. Air Compressor:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Gast Manufacturing Inc.
      2) General Air Products, Inc.
      3) Viking Corporation.
   b. Standard: UL's "Fire Protection Equipment Directory."
   c. Motor Horsepower: Fractional.
      1) Power: 120-V ac, 60 Hz, single phase.
   d. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
   e. Include filters, relief valves, coolers, automatic drains, and gauges.

2.05 DRY-SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

A. Dry-Sprinkler System Nitrogen Generator with Purge/Vent: Nitrogen generator system to serve dry sprinkler zones for piping corrosion mitigation, including system venting.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Engineered Corrosion Solutions.
      b. General Air Products, Inc.
      c. Potter Electric Signal Company, LLC.
      d. South-Tek Systems, LLC.
   2. Description: Nitrogen generator system for dry-sprinkler system providing required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.
   3. Standards:
      a. FM Approvals 1035.
      b. UL 508A listed.
   4. Nitrogen Generator:
      a. Wall-mounted or skid-mounted nitrogen generator to provide minimum nitrogen purity of 98 percent to designated sprinkler systems.
      b. Power: 120 V ac.
      c. Bypass mode and nitrogen generating mode.
      d. Minimum Capacity: As recommended by manufacturer.
   5. Air Compressor:
      a. Standard: UL's "Fire Protection Equipment Directory."
      b. Motor Horsepower: Fractional.
         1) Power: 120 V ac, 60 Hz, single phase.
      c. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
      d. Include filters, relief valves, coolers, automatic drains, and gauges.
      e. Minimum Capacity: Match capacity of nitrogen generator.
   6. Automatic Purge Vent/Valve:

      a. Vents oxygen during system nitrogen fill.
      b. Automatically closes when 98 percent minimum nitrogen has been reached.
      c. Sized to allow correct purge rate per manufacturer's written instructions and with 14 days.

d. Provide one venting device for each dry/preaction sprinkler system zone.
e. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.

7. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:
   a. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of the automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
   b. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.

2.06 SPRINKLER PIPING SPECIALTIES

A. General Requirements for Dry-Pipe System Fittings: UL listed for dry-pipe service.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing, Inc.
   b. Reliable Automatic Sprinkler Co., Inc. (The).
   c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. AGF Manufacturing, Inc.
   b. Elkhart Brass Mfg. Co., Inc.
   c. Fire-End & Croker Corporation.
   d. Potter Electric Signal Company, LLC.
   e. Potter Roemer LLC; a Division of Morris Group International.
2. Standard: UL 199.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AGF Manufacturing, Inc.
   b. Triple R Specialty.
   c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   d. Victaulic Company.
   e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.07 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc. (The).
3. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
4. Venus Fire Protection Ltd.
5. Victaulic Company.
6. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: bronze.

F. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
c. Victaulic Company.
d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.08 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Notification Appliances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Notifier; Honeywell International, Inc.
b. Potter Electric Signal Company, LLC.
2. Electric Bell:
a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch minimum diameter.
d. Voltage: 24 V dc.
e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.

C. Pressure Switches - Water-Flow Alarm Detection:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Barksdale, Inc.
b. Detroit Switch, Inc.
c. Potter Electric Signal Company, LLC.
d. System Sensor.
e. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
f. United Electric Controls Co.

g. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised, pressure-activated water-flow switch.
4. Components: Two single-pole, double-throw switches.
5. Design Operation: Rising pressure to 6 psi, plus or minus 2 psi signals water flow.
6. Adjustability: Each switch is to be independently adjustable.
7. Wire Separation: Pressure switch to provide separation of wiring to each switch connection to allow for low and high volume connections to comply with NFPA 70 Article 760 requirements.

D. Pressure Switches - Low/High Air Pressure Supervisory:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Barksdale, Inc.
b. Detroit Switch, Inc.
c. Potter Electric Signal Company, LLC.
d. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
e. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised pressure supervisory switch.
4. Components: Two single-pole, double-throw switches.
5. Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
6. Adjustability: Each switch is to be independently adjustable.
7. Wire Separation: Pressure switch shall provide for separation of wiring to each switch connection to allow for low and high voltage connections to comply with NFPA 70 Article 760 requirements.

E. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve Company; a division of McWane, Inc.
b. Potter Electric Signal Company, LLC.
c. System Sensor.
2. General Requirements for Valve Supervisory Switches:
a. Standard: UL 346.
b. Type: Electrically supervised.
c. Design: Signals that controlled valve is in other than fully open position.
d. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on the valve and valve is fully open.
3. Requirements for OS&Y Valve Supervisory Switches:
a. Components: One or two single-pole, double-throw switches.
b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
e. Trip Rod Length: Adjustable.
4. Requirements for PIV and Butterfly Valve Supervisory Switches:
a. Components: Two single-pole, double-throw switches.
b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Removable nipple.
d. Trip Rod Length: Adjustable.
5. Requirements for Ball Valve Supervisory Switch:
a. Components: One single-pole, double-throw switch.

b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves or backflow preventers sized from up to NPS 2.

2.09 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AGF Manufacturing, Inc.
2. AMETEK, Inc.
3. Ashcroft Inc.
4. Brecco Corporation.
5. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gauge Range: 0- to 250-psig minimum.

E. Label: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gauge: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

A. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 33 14 15 "Site Water Distribution Piping."

B. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.

3.03 INSTALLATION OF PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.

J. Connect compressed-air supply to dry-pipe sprinkler piping.

K. Connect air compressor to the following piping and wiring:
   1. Pressure gauges and controls.
   2. Electrical power system.
   3. Fire-alarm devices, including low-pressure alarm.

L. Install alarm devices in piping systems.

M. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13.

N. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

O. Drain dry-pipe sprinkler piping.

P. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices air compressors.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.04 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Rolled Grooved Joints: Rolled-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.05 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
   a. Install air compressor and compressed-air-supply piping.
   b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
   c. Install compressed-air-supply piping from building's compressed-air piping system.

3.06 INSTALLATION OF SPRINKLERS

A. Install sprinklers with water supply from heated space. Do not install pendent or sidewall sprinklers in areas subject to freezing.

3.07 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.08 NITROGEN-GENERATION, CORROSION-MITIGATION SYSTEM

A. Install in accordance with manufacturer's written installation instructions.

B. Locate purge vent/valve in accordance with manufacturer's written installation instructions.

C. Route alarm signals in code-approved electrical conduit from nitrogen generator system control panel to the supervisory circuit of BAS.

3.09 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run air compressors.
6. Coordinate with fire-alarm tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, dry-pipe sprinkler system, NPS 2 and smaller, shall be the following:
   1. Standard-weight pipe with threaded ends; black-iron threaded fittings; and threaded joints.

D. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends and threaded joints.
   2. Standard-weight, black-steel pipe with rolled-grooved ends; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, dry-pipe sprinkler system, NPS 5 and NPS 6, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends.
   2. Standard-weight, galvanized-steel pipe with rolled-grooved ends, grooved-end fittings for steel piping and grooved joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Spaces Subject to Freezing: Upright sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Grooved-joint expansion joints.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
   2. Shurjoint; a part of Aalberts Integrated piping Systems.
   3. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: Galvanized, ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

PART 3 - EXECUTION

3.01 INSTALLATION OF EXPANSION JOINTS

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install grooved-joint expansion joints to grooved-end steel piping.

3.02 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

END OF SECTION

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Sleeves.
2. Sleeve-seal systems.
3. Silicone sealants.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.02 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, LLC.
2. GPT; an EnPro Industries company.
3. Metraflex Company (The).

B. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Composite plastic.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.

2.03 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Sherwin-Williams Company (The).
      c. The Dow Chemical Company.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6 : Sleeve-seal fittings.
      b. Piping NPS 6 and Larger: Sleeve-seal fittings.
   2. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6 : Sleeve-seal fittings.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Sleeve-seal fittings.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6 : Stack-sleeve fittings.
      b. Piping NPS 6 and Larger: Stack-sleeve fittings.
   4. Interior Partitions:
      a. Piping Smaller Than NPS 6: PVC pipe sleeves.

END OF SECTION

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Escutcheons.

1.03 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BrassCraft Manufacturing Co.; a Masco company.
   2. Keeney Manufacturing Company (The).
   3. ProFlo; a Ferguson Enterprises, Inc. brand.

2.02 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; exposed-rivet hinge; and spring-clip fasteners.

2.03 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
      b. Chrome-Plated Piping: One-piece cast brass with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Filled-system thermometers.
2. Dial-type pressure gages.
3. Gage attachments.
4. Sight flow indicators.

B. Related Requirements:
1. Section 22 11 13 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Section 22 11 19 "Domestic Water Piping Specialties" for water meters.
3. Section 22 15 13 "General-Service Compressed-Air Piping" for compressed air gages.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Miljoco Corporation.
b. Trerice, H. O. Co.
c. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel ; 6-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device ; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
a. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

2.02 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. Weksler Glass Thermometer Corp.
d. WIKA Instrument Corporation.
2. Standard: ASME B40.100.

3. Case: Sealed type(s); cast aluminum or drawn steel ; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.03 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston -type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.04 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ernst Flow Industries.
2. KOBOLD Instruments, Inc. - USA.
3. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install remote-mounted pressure gages on panel.

C. Install valve and snubber in piping for each pressure gage for fluids.

D. Install test plugs in piping tees.

E. Install pressure gages in the following locations:
1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

C. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

B. Scale Range for Domestic Water Piping: 0 to 160 psi.

END OF SECTION

SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Brass ball valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61and NSF 372.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and soldered ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on steel valves.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for solder-joint connections.
   6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES

A. Brass Ball Valves, One-Piece:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo.
b. KITZ Corporation.
c. WATTS.
2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Forged brass or bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass or stainless steel.
h. Ball: Chrome-plated brass or stainless steel.
i. Port: Reduced.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
2. Brass ball valves, two-piece with full port and brass trim. Provide with threaded solder or press connection-joint ends.
3. Brass ball valves, three-piece with full port and brass trim.

B. Pipe NPS 2-1/2 and Larger:
1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

END OF SECTION

SECTION 22 05 23.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Iron, grooved-end butterfly valves.
2. CPVC butterfly valves.
3. PVC butterfly valves.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.
1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.

3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

H. Valves in Insulated Piping: With 2-inch stem extensions.

2.02 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Ductile Iron, Grooved-End Butterfly Valves, 175 CWP:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. NIBCO INC.
b. Victaulic Company.
c. Zurn Industries, LLC.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

END OF SECTION

SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Bronze swing check valves.
2. Bronze swing check valves, press ends.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.
1. Certification that products comply with NSF 61 and NSF 372.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Milwaukee Valve Company.
c. NIBCO INC.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Valves; a Crane Co. brand.
b. Milwaukee Valve Company.
c. NIBCO INC.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

C. Bronze Swing Check Valves, Press Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Milwaukee Valve Company.
c. NIBCO INC.
2. Description:
a. Standard: MSS SP-80 and MSS SP-139.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 584, bronze.
e. Ends: Press.
f. Press Ends Connection Rating: Minimum 200 psig.
g. Disc: Brass or bronze.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

F. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Pump-Discharge Check Valves:
a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flanged.
4. For Steel Piping, NPS 2 and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
6. For Steel Piping, NPS 5 and Larger: Flanged.
7. For Grooved-End Copper Tubing and Steel Piping: Grooved.

3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze swing check valves with bronze nonmetallic disc, Class 125, with soldered or threaded end connections.
2. Bronze swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:
1. Iron swing check valves with metal seats, Class 125, with threaded flanged end connections.
2. Iron swing check valves with closure control lever and spring weight, Class 125, with threaded or flanged end connections.
3. Iron, grooved-end swing check valves, 300 CWP.
4. Iron, center-guided check valves with compact wafer, Class 125.

5. Iron, center-guided check valves with, resilient seat, Class 125, with threaded or flanged end connections.
6. Iron, dual-plate check valves with resilient seat, Class 125, with threaded or flanged end connections.
7. Iron, single-plate check valves with resilient seat, Class 125, with threaded or flanged end connections.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Equipment supports.

B. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   3. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.03 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Copper Pipe and Tube Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.

2.03 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.04 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 23 "Interior Painting." Section 09 96 00 "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   6. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
   7. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. C-Clamps (MSS Type 23): For structural shapes.
   6. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections of Sections 220548 Vibration and Seismic Control for Plumbing Piping and Equipment or 220548.13 Vibration Control for Plumbing Piping and Equipment, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Craftmark Pipe Markers.
c. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Carlton Industries, LP.

3. Champion America.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Black.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.04 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.

B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.05 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Champion America.
   3. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.03 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   3. At access doors, manholes, and similar access points that permit view of concealed piping.
   4. Near major equipment items and other points of origination and termination.
   5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   6. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:
   1. Domestic Water Piping
      a. Background: Safety green.
      b. Letter Colors: White.
   2. Sanitary Waste and Storm Drainage Piping:
      a. Background Color: Safety black.
      b. Letter Color: White.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
   2. Valve-Tag Colors:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
   3. Letter Colors:
      a. Cold Water: White.
      b. Hot Water: White.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulating the following plumbing piping services:
1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Storm-water piping exposed to freezing conditions.
6. Supplies and drains for handicap-accessible lavatories and sinks.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.04 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
2. 850 deg F.
3. Factory-fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

2.03 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.04 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. 3M Industrial Adhesives and Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.
c. Knauf Insulation.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.05 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Buckaroos, Inc.

b. Just Manufacturing.
c. McGuire Manufacturing.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on

each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.08 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. NPS 1 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/4 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   2. NPS 1-1/2 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Domestic Chilled Water (Potable):
1. All Pipe Sizes: Insulation shall be one of the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Stormwater and Overflow:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Sanitary Waste Piping Where Heat Tracing Is Installed:
1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Copper tube and fittings.

1.03 ACTION SUBMITTALS

A. Product Data:
   1. Pipe and tube.
   2. Fittings.
   3. Joining materials.
   4. Transition fittings.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

G. Wrought Copper Unions: ASME B16.22.

H. Copper-Tube, Push-on-Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. NIBCO INC.
      c. Victaulic Company.
      d. Viega.
   2. Description:
      a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
      b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.03 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.

2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Plastic-to-Metal Transition Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Aquatherm.
b. NIBCO INC.
c. Spears Manufacturing Company.
2. Description:
a. PVC four-part union.
b. Brass or stainless steel threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

2.04 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Standard: ASSE 1079.
2. Pressure Rating: 150 psig.
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Nipples:
1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed soldered joints.
2. CPVC, socket fittings; and solvent-cemented joints.
3. PVC, socket fittings; and solvent-cemented joints.
4. Polypropylene (PP-R), pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L; cast or wrought copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, or; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Drawn-temper copper tube, or; grooved-joint, copper-tube appurtenances; and grooved joints.

4. Stainless steel, Schedule 10 pipe; grooved-joint fittings, and grooved joints.
5. CPVC, ; socket fittings; and solvent-cemented joints.
6. PVC, ; socket fittings; and solvent-cemented joints.
7. Polypropylene (PP-R), pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

3.02 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.03 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

E. Install valves according to the following:
1. Section 22 05 23.12 "Ball Valves for Plumbing Piping."
2. Section 22 05 23.13 "Butterfly Valves for Plumbing Piping."
3. Section 22 05 23.14 "Check Valves for Plumbing Piping."
4. Section 22 05 23.15 "Gate Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Comply with requirements for vibration isolation and seismic-control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

J. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install PEX tubing with loop at each change of direction of more than 90 degrees.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 22 05 19 "Meters and Gages for Plumbing Piping."

U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."

V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.04 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

L. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
   2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
   3. PVC Piping: Join according to ASTM D2855.

M. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

N. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.

O. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.05 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.06 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.07 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.08 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.09 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.10 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.

f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers for domestic water piping.
6. Outlet boxes.
7. Hose bibbs.
8. Wall hydrants.
9. Water-hammer arresters.
10. Trap-seal primer device.
11. Flexible connectors.
12. Water meters.

B. Related Requirements:
1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for fire water-service backflow prevention devices.
2. Section 22 05 19 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
3. Section 22 11 16 "Domestic Water Piping" for water meters.

1.03 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze .

B. Hose-Connection Vacuum Breakers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. MIFAB, Inc.
c. WATTS.
d. Zurn Industries, LLC.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Rough bronze.

C. Pressure Vacuum Breakers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Accessories:
a. Valves: Ball type, on inlet and outlet.

2.04 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze cast silicon copper alloy or stainless steel for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 12 psi maximum, through middle third of flow range.
5. Body: Bronze cast silicon copper alloy or stainless steel for NPS 3 and smaller.
6. End Connections: Threaded for NPS 3 and smaller.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
a. Valves NPS 3 and Smaller: Ball type with threaded ends on inlet and outlet.

C. Beverage-Dispensing-Equipment Backflow Preventers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel or non-metallic .
6. End Connections: Threaded or flare.

D. Backflow-Preventer Test Kits :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. FEBCO; A WATTS Brand.
c. WATTS.
2. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

2.05 BALANCING VALVES

A. Automatic Flow Control Balancing Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Caleffi North America.
b. IMI Hydronic Engineering Inc.
c. ThermOmegaTech.
2. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
3. Pressure Rating: 200 psig.
4. Size: NPS 2 or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscale polymer.
7. End Connections: Threaded or solder joint.

2.06 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Leonard Valve Company.
c. POWERS; A WATTS Brand.
d. WATTS.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated .

B. Primary, Electronic, Water Mixing Valve Assemblies :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Engineering Company; a Division of Morris Group International.
   b. Leonard Valve Company.
   c. POWERS; A WATTS Brand.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed, electronically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or solder joint inlets and outlet.
7. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
8. Valve Finish: Bronze.
9. Digital temperature control and monitoring module.
   a. Controls temperature within plus or minus 2 deg F.
   b. User programmable at module or through BAS.
   c. ASHRAE 188 compliance.
   d. Local and remote monitoring.
   e. BACNet protocol language(s).
   f. 115 V ac, 60 Hz.
   g. Battery backup.

2.07 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Keckley Company.
   b. Titan Flow Control, Inc.
   c. WATTS.
   d. Zurn Industries, LLC.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch .
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch .
   c. Strainers NPS 5 and Larger: 0.10 inch .
7. Drain: Factory-installed, hose-end drain valve.

2.08 OUTLET BOXES

A. Icemaker Outlet Boxes :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guy Gray, IPS Corporation.
   b. Oatey.

c. Sioux Chief Manufacturing Company, Inc.
d. Water-Tite, IPS Corporation.
2. Mounting: Recessed. Fire rated.
3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.09 HOSE BIBBS

A. Hose Bibbs :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MIFAB, Inc.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze .
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle .
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Vacuum Breaker Wall Hydrants :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Champion - Arrowhead.
b. Jay R. Smith Mfg Co; a division of Morris Group International.
c. WATTS.
d. Zurn Industries, LLC.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Automatic draining with integral air-inlet valve.
4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key or wheel handle.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. MIFAB, Inc.

c. Precision Plumbing Products.
d. Sioux Chief Manufacturing Company, Inc.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Piston .
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Precision Plumbing Products.
b. Sioux Chief Manufacturing Company, Inc.
c. WATTS.
d. Zurn Industries, LLC.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.13 FLEXIBLE CONNECTORS

A. Flexible connectors as specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" or 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

2.14 WATER METERS

A. Turbine-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Badger Meter, Inc.
b. Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.
c. Neptune Technology Group Inc.
2. Standard: AWWA C701.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: Turbine; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.
a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
1) System shall be capable of transmitting data using AMR/AMI technology.
6. Case: Bronze Epoxy-coated cast iron.
7. End Connections: Threaded or flanged.

B. Ultrasonic-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Badger Meter, Inc.
b. Master Meter, Inc.
c. Neptune Technology Group Inc.
2. Standard: Applicable portions of AWWA C700.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: Ultrasonic open flow tube; totalization meter.

5. Registration: In gallons or cubic feet as required by utility company.
   a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
      1) System shall be capable of transmitting data using AMR/AMI technology.
6. Case: Engineered polymer .
7. End Connections: Threaded or flanged.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Water Control Valves: Install with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gauges on inlet and outlet.

C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Y-Pattern Strainers: For water, install on supply side of each control valve solenoid valve and pump.

F. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."

G. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."

H. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

I. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.02 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.03 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.04 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.05 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Outlet boxes.
6. Wall hydrants.
7. Trap-seal primer device.
8. Water meters.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.06 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each pressure vacuum breaker reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Stainless-steel drainage pipe and fittings.

B. Related Requirements:
1. Section 22 13 13 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 22 13 29 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 22 66 00 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.05 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
1. Soil, Waste, and Vent Piping: 10-foot head of water.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.02 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 74, Service class(es).

C. Gaskets: ASTM C 564, rubber.

D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Charlotte Pipe and Foundry Company.
2. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.05 STAINLESS-STEEL DRAINAGE PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
2. BLÜCHER; A Watts brand.
3. Josam Company.

B. Description: Comply with requirements of ASME A112.3.1, drainage pattern.

C. Material: Type 304 or 316L stainless steel.

D. Pipe Construction: Seamless.

E. Internal Sealing Rings: EPDM.

F. Joints: Single or double, socket and spigot ends.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
   2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.
   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

Q. Install engineered soil and waste and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

R. Install underground, ductile-iron, force-main piping according to AWWA C600.
   1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
   2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

T. Install force mains at elevations indicated.

U. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping.
a. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary waste gravity-flow piping.
a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: nonpressure transition couplings.

B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 : Use dielectric.

3.05 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for cast-iron stainless-steel and soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

E. Support vertical runs of cast iron steel stainless-steel and soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.
   a. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:
   1. Sanitary Sewer: To exterior force main.
   2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
      b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      c. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
      b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      d. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
      a. Isolate test source and allow to stand for four hours.
      b. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   4. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
   4. ABS pipe, ABS socket fittings, and solvent-cemented joints.
   5. Dissimilar Pipe-Material Couplings: nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings ; CISPI hubless-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
   4. Dissimilar Pipe-Material Couplings: nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
   4. Dissimilar Pipe-Material Couplings, nonpressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
   4. Dissimilar Pipe-Material Couplings, nonpressure transition couplings.

F. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
   1. Service class, cast-iron soil piping; gaskets; and gasketed calking materials; and calked joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; coupled joints.
   3. Dissimilar Pipe-Material Couplings: nonpressure transition couplings.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:
1. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 07 72 00 "Roof Accessories" for preformed flashings.
3. Section 07 84 13 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 22 13 23 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 22 14 23 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
6. Section 22 43 00 "Healthcare Plumbing Fixtures" for plaster sink interceptors.
7. Section 33 42 00 "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.03 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.02 BACKWATER VALVES

A. Drain-Outlet Backwater Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.03 CLEANOUTS

A. Cast-Iron Exposed Floor Cleanouts :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
3. Size: Same as connected branch.
4. Type: Cast-iron soil pipe with cast-iron ferrule .
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required .
7. Outlet Connection: Threaded.
8. Closure: Brass plug with tapered threads .
9. Adjustable Housing Material: Cast iron with threads .
10. Frame and Cover Material and Finish: Stainless steel .
11. Frame and Cover Shape: Round .
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

B. Cast-Iron Wall Cleanouts :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
a. Brass .
b. Countersunk head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Round , nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

2.04 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Oatey Co.
b. ProVent Systems.
c. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps :
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
a. NPS 2: 4-inch- minimum water seal.

b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings :
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Sleeve Flashing Device :
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings :
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Expansion Joints :
1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install backwater valves in building drain piping.
1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install deep-seal traps on floor drains and other waste outlets, if indicated.

G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

I. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

J. Install wood-blocking reinforcement for wall-mounting-type specialties.

K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 PIPING CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.03 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 19.13 - SANITARY DRAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Floor drains.
2. Floor sinks.

1.03 DEFINITIONS

A. HDPE: High-density polyethylene.

B. PE: Polyethylene.

C. PP: Polypropylene.

D. PVC: Polyvinyl chloride.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. Wade; a subsidiary of McWane Inc.
d. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket.
11. Top or Strainer Material: Stainless steel.
12. Top of Body and Strainer Finish: Brushed stainless steel.
13. Top Shape: Square.
14. Top Loading Classification: Medium Duty .
15. Funnel: Not required
16. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
17. Trap Material: Cast iron.
18. Trap Pattern: Standard P-trap.

19. Trap Features: Trap-seal primer valve drain connection.

2.03 FLOOR SINKS

A. Cast-Iron Floor Sinks :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. Wade; a subsidiary of McWane Inc.
d. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Internal Strainer: Dome.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: Stainless steel, removable.
12. Top of Body and Grate Finish: Brushed stainless steel.
13. Top Shape: Square.
14. Top Loading Classification: No traffic.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:
a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
a. Maintain integrity of waterproof membranes where penetrated.
5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install open drain fittings with top of hub 1 inch above floor.

3.02 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.03 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying

unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 13 23 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Oil interceptors.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of plastic interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Piping connections. Include size, location, and elevation of each.
   2. Interface with underground structures and utility services.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.06 FIELD CONDITIONS

PART 2 - PRODUCTS

2.01 OIL INTERCEPTORS

A. Plastic Oil Interceptors: Removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Striem.
      b. Town & Country Plastics, Inc.
      c. MIFAB, Inc.
   2. Inlet, Outlet, and Vent Piping Connections: hub or threaded, unless otherwise indicated.
   3. Cover: Plastic load.
   4. Capacities and Characteristics:
      a. Capacity: 110 Gal .
      b. Flow Rate: 75 GPM .
      c. Inlet and Outlet Pipe Size: 4" NPS .
      d. End Connections: Hub .
      e. Cleanout: Integral or field installed on outlet.
      f. Vent Pipe Size: 3" NPS .
      g. Mounting: Recessed, flush with floor .
      h. Flow-Control Fitting: Not required .
   5. Accessories:
      a. Oil Monitoring System: Control panel with cable interfaced with float to monitor oil levels within the interceptor. Oil monitoring system shall be provided with the oil

interceptor and by the same manufacturer. Interconnect the control panel with the building automation system indicating an alarm condition.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.02 INSTALLATION

A. Set interceptors level and plumb.

B. Set tops of grating frames and grates flush with finished surface.

C. Set plastic interceptors level and plumb.

D. Install piping according to Section 22 13 16 "Sanitary Waste and Vent Piping."

E. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

3.03 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.04 IDENTIFICATION

A. Identification materials and installation are specified in Section 31 20 00 "Earth Moving."
   1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
   2. Use warning tapes or detectable warning tape over ferrous piping.
   3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Oil interceptors.

3.05 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION

SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Submersible sump pumps.
   2. Sump pump basin and basin covers.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.02 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bell & Gossett; a Xylem brand.
      b. Grundfos Pumps Corp.
      c. Zoeller Company.
   2. Description: Factory-assembled and -tested sump-pump unit.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
   4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, design for clear wastewater handling, and keyed and secured to shaft.
   6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
   7. Seal: Mechanical.
   8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      a. Motor Housing Fluid: Oil.

9. Controls:
   a. Enclosure: NEMA 250, Type 4X, wall mounted.
   b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   c. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
   d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
10. Control-Interface Features:
   a. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      1) On-off status of pump.
      2) Alarm status.

2.03 SUMP-PUMP CAPACITIES AND CHARACTERISTICS

A. Unit Capacity: see schedules.

B. Number of Pumps: see schedules.

2.04 SUMP-PUMP BASIN AND BASIN COVERS

A. Basins: Factory-fabricated, water tight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Re-enforced concrete.

2. Reinforcement: Mounting plates for pumps, fittings, and accessories.

3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, and in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.05 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.02 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.03 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.04 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Flow-control, electric, tankless, domestic-water heaters.
   2. Domestic-water heater accessories.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. Flow-control, electric, tankless, domestic-water heaters.
   2. Domestic-water heater accessories.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.04 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.05 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Electric, Tankless, Domestic-Water Heaters: One year(s).

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.02 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Stiebel Eltron, Inc.
      b. Chronomite Laboratories, Inc; a division of Morris Group International.
      c. Bradley Corporation.
   2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
   3. Standard: UL 499 for electric, tankless, (domestic-water-heater) heating appliance.
   4. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
      a. Connections: ASME B1.20.1 pipe thread.
      b. Pressure Rating: 150 psig .
      c. Heating Element: Resistance heating system.
      d. Temperature Control: Flow-control fitting.
      e. Safety Control: High-temperature-limit cutoff device or system.
      f. Jacket: Aluminum or steel with enameled finish or plastic.

5. Support: Bracket for wall mounting.

2.03 DOMESTIC-WATER HEATER ACCESSORIES

A. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

B. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping."

C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

D. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

E. Install thermometers on inlet and outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

F. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

G. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

H. Fill electric, domestic-water heaters with water.

I. Charge domestic-water expansion tanks with air to required system pressure.

J. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.02 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

END OF SECTION

SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Wall-mounted water closets.
2. Flushometer valves.
3. Toilet seats.
4. Supports.

1.03 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
1. Flushometer-Valve Repair Kits: Equal to 25 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED WATER CLOSETS

A. Water Closets, Wall Mounted, Top Spud, Refer to Drawings for Use Type: :
1. Manufacturers: Subject to compliance with requirements, undefined:
a. American Standard.
b. Sloan Valve Company.
c. Zurn Industries, LLC.
2. Bowl:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Style: Flushometer valve.
e. Height: Standard and ADA.
f. Rim Contour: Elongated.
g. Water Consumption: 1.1 gal per flush.
h. Spud Size and Location: NPS 1-1/2; top.
3. Support: Water closet carrier.

4. Water-Closet Mounting Height: Standard Handicapped/elderly according to ICC/ANSI A117.1.

2.02 FLUSHOMETER VALVES

1. Manufacturers: Subject to compliance with requirements, undefined:
   a. American Standard.
   b. Sloan Valve Company.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

2.03 TOILET SEATS

A. Toilet Seats :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Bemis Manufacturing Company.
   c. Church Seats; Bemis Manufacturing Company.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

2.04 SUPPORTS

A. Water Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. WATTS.
   c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Water-Closet Installation:
1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:
1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.04 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 13.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Wall-hung urinals.
2. Urinal flushometer valves.
3. Supports.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
2. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.

PART 2 - PRODUCTS

2.01 WALL-HUNG URINALS

A. Urinals - Wall Hung, Back Outlet, Washdown: Accessible.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Sloan Valve Company.
c. Zurn Industries.
2. Fixture:
a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
b. Material: Vitreous china.
c. Type: Washdown with extended shields.
d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
e. Water Consumption: 0.125 gpf.
f. Spud Size and Location: NPS 3/4, top.
g. Outlet Size and Location: NPS 2, back.
h. Color: White.
3. Waste Fitting:
a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 2.
4. Support: with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

5. Urinal Mounting Height: Standard Handicapped/elderly according to ICC A117.1.

2.02 URINAL FLUSHOMETER VALVES

A. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Sloan Valve Company.
c. Zurn Industries, LLC.
2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: *0.125 gal* per flush.
12. Minimum Inlet: NPS 3/4.
13. Minimum Outlet: NPS 3/4.

2.03 SUPPORTS

A. Type II Urinal Carrier:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Urinal Installation:
1. Install urinals level and plumb according to rough-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC A117.1.
5. Install trap-seal liquid in waterless urinals.

B. Support Installation:
1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:
   1. Install flushometer-valve water-supply fitting on each supply to each urinal.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
   4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.
   3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

E. Joint Sealing:
   1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
   2. Match sealant color to urinal color.
   3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 PIPING CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.04 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Vitreous-china, counter-mounted lavatories.
2. Vitreous-china, wall-mounted lavatories.
3. Solid-surface, wall mounted lavatory systems.
4. Manually operated lavatory faucets.
5. Supply fittings.
6. Waste fittings.
7. Lavatory supports.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

PART 2 - PRODUCTS

2.01 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory - Vitreous China, Undercounter Mounted :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Kohler Co.
c. TOTO USA, INC.
2. Fixture:
a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: For undercounter mounting.
c. Nominal Size: Oval, 19 by 16 inches.
d. Faucet-Hole Punching: No holes.
e. Faucet-Hole Location: On countertop.
f. Color: White.
g. Mounting Material: Sealant and undercounter mounting kit.

2.02 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory - Wheelchair, Vitreous China, Wall Mounted :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Kohler Co.
c. Sloan Valve Company.
2. Fixture:
a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: Slab or wheelchair.
c. Nominal Size: Rectangular, 27 by 20 inches.
d. Faucet-Hole Punching: One hole.
e. Faucet-Hole Location: Top.

f. Color: White.
g. Mounting: For concealed-arm carrier.

3. Support: Type II, concealed-arm lavatory carrier with escutcheons. Include rectangular, steel uprights.

B. Lavatory Mounting Height: Handicapped/elderly in accordance with ICC A117.1. Lavatory – Solid Surface, Wall Mounted:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bradley Corp.
   b. Approved Equal
2. Fixture:
   a. Standard: CAS B45.5/IAPMO Z124
   b. Type: Single-piece, Terreon, wall mounted
   c. Nominal Size: Custom, refer to Drawings.
   d. Faucet-Hole Punching: One per faucet, see Drawings.
   e. Faucet-Hole Location: Top.
   f. Color: Confirm with Architect.
   g. Mounting: Wall bracket, ICC A117.1.

2.03 SENSOR OPERATED LAVATORY FAUCETS

A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Lavatory Faucets - Sensor Type: Single-Control Mixing, Commercial, :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Delta.
   c. T&S Brass and Bronze Works, Inc.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Maximum Flow: 0.25 gal. per metering cycle.
9. Mounting Type: Deck, exposed.
10. Spout: Rigid type.
11. Spout Outlet: 0.35 gpm Aerator.
12. Operation: Solenoid, sensor.
13. Drain: Not part of faucet.

2.04 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:
1. NPS 3/8.
2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.05 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/4.
2. Material:
a. Chrome-plated, one-piece, cast-brass trap with swivel 0.029-inch- thick tubular brass wall bend ; and chrome-plated, brass or steel wall flange.
b. Stainless steel, two-piece trap and swivel elbow with 0.012-inch thick stainless steel tube to wall, and stainless steel wall flange.

2.06 LAVATORY SUPPORTS

A. Lavatory Carrier:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS.
c. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.03 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.06 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Service sinks.
2. Kitchen/utility sinks.
3. Manually operated sink faucets.
4. Automatically operated sink faucets.
5. Supply fittings.
6. Waste fittings.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

PART 2 - PRODUCTS

2.01 SERVICE SINKS

A. Service Sinks - Terrazzo, Floor Mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company; a Division of Morris Group International.
b. Fiat Products.
c. Florestone Products Co., Inc.
2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:
a. Material: Marble chips cast in portland cement to produce a compressive strength of not less than 3000 psi, seven days after casting.
b. Shape: Square.
c. Nominal Size: 36 by 36 inches.
d. Height: 12 inches with dropped front.
e. Tiling Flange: Not required.
f. Rim Guard: On front top surfaces.
g. Color: Not applicable.
h. Drain: Grid with NPS 3 outlet.
4. Mounting: On floor and flush to wall.

2.02 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eagle Group.
b. Elkay.
c. Just Manufacturing.
2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:
a. Standard: ASME A112.19.3/CSA B45.4.

b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back.
c. Number of Compartments: One Two.
d. Material: 18 gauge, Type 304 stainless steel.
e. Compartment:
1) Drain: NPS 1-1/2 tailpiece with stopper.
2) Drain Location: Centered in compartment.
3) Depth: Wheelchair accessible.
f. Each Compartment:
1) Drains: NPS 1-1/2 tailpiece with stopper.
2) Drain Location: Centered in compartment.
3) Depth: Wheelchair accessible.

4. Faucet(s):
a. Number Required: One.
b. Mounting: On ledge.
5. Supply Fittings:
a. Standard: ASME A112.18.1/CSA B125.1.
b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
1) Operation: Wheel handle.
2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
6. Waste Fittings:
a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):
1) Size: NPS 1-1/2.
2) Material:
a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall ; and chrome-plated brass or steel wall flange.
c. Continuous Waste:
1) Size: NPS 1-1/2.
2) Material: Chrome-plated, 17-gauge brass tube.
7. Mounting: On counter with sealant.

2.03 MANUALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Manual Type: Two-handle mixing,
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Standard.
b. Delta.
c. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Centerset.
6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm.
9. Mounting Type: Deck, exposed.
10. Valve Handle(s): 4-inch wrist blade.

11. Spout Type: Swivel gooseneck.
12. Vacuum Breaker: Required for hose outlet.
13. Spout Outlet: Laminar flow Hose thread in accordance with ASME B1.20.7.

C. Commercial Service Sink Faucets - Manual Type:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Delta.
   c. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
4. Faucet:
   a. Standards:
      1) ASME A112.18.1/CSA B125.1.
      2) NSF 61 and NSF 372.
      3) ICC A117.1.
      4) ASSE 1001 (VB).
   b. Finish: Polished chrome plated.
   c. Handles: 4 arms.
   d. Cartridges: Ceramic.
   e. Brace: Adjustable top brace.

2.04 AUTOMATICALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Automatic Type: Hard-wired, electronic-sensor-operated, mixing,.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard.
   b. Delta.
   c. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: Centerset.
7. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: Polished chrome1 plate.
9. Maximum Flow Rate: 0.5 gpm.
10. Mounting Type: Deck.
11. Spout Type: Swivel, gooseneck.
12. Spout Outlet: Aerator.
13. Thermostatic Mixing Valve: Below deck, with check valves.
14. Control Module: Below deck, water-resistant module with internal flow setting switches.
15. Drain: Not part of faucet.

2.05 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:
1. NPS 3/8.
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.06 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:
1. Size: NPS 1-1/2.
2. Material:
a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall ; and chrome-plated brass or steel wall flange.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.
1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.03 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.06 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 47 13 - DRINKING FOUNTAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes drinking fountains and related components.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include operating characteristics, and furnished specialties and accessories.

PART 2 - PRODUCTS

2.01 DRINKING FOUNTAINS

A. Drinking Fountains : Stainless steel, wheelchair accessible, wall mounted.
   1. Stainless-Steel Drinking Fountains:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Elkay.
         2) Halsey Taylor.
         3) Oasis International.
   2. Standards:
      a. Comply with ASME A112.19.3/CSA B45.4.
      b. Comply with NSF 61 and NSF 372.
      c. Comply with ICC A117.1.
   3. Type Receptor: Slab With back.
   4. Receptor Shape: Rectangular.
   5. Back Panel: Stainless-steel wall plate behind drinking fountain.
   6. Bubblers: Two, with adjustable stream regulator, located on deck.
   7. Maximum Water Flow: 0.15 gpm.
   8. Control: Push bar.
   9. Drain: Grid type with NPS 1-1/4 tailpiece.
   10. Supply: NPS 3/8 with shutoff valve.
   11. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
   12. Support: Type II water cooler carrier.
   13. Drinking Fountain Mounting Height: Standard Handicapped/elderly according to ICC A117.1.

2.02 SUPPORTS

A. Type II Water Cooler Carrier:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. WATTS.
      c. Zurn Industries, LLC.
   2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set pedestal drinking fountains on floor.

C. Install recessed drinking fountains secured to wood blocking in wall construction.

D. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.05 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 00 91 - HVAC PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. General provisions and other HVAC systems are specified in other Sections of Division 23.

B. Performance verification is ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Bid Set.

C. This Section covers HVAC systems performance verification, as required to demonstrate that the equipment and systems of Division 23 are ready for safe and satisfactory operation, as defined by the Bid Set. Performance verification shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.

D. The general requirements of the commissioning process and the duties of the Commissioning Authority are detailed in Section 23 00 90, Commissioning. Become familiar with the requirements and coordination obligation of Section 23 00 90, Commissioning and the commissioning schedule issued by the Commissioning Authority as they apply to the work of Division 23, and execute the performance verification responsibilities within the commissioning process as specified therein.

E. Performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the HVAC equipment and systems provided by this Division.

F. Verify, at a minimum, the performance of the following systems and equipment and witness the following tests:
   1. Variable frequency drives.
   2. Vibration isolation.
   3. Automatic air vents.
   4. Backflow preventers.
   5. Expansion tanks.
   6. Steam pressure reducing valves.
   7. Temperature maintenance cable.
   8. Thermostatic air vents.
   9. Vacuum breakers.
   10. Chilled water system.
   11. Hot water system.
   12. Steam supply piping.
   13. Underground chilled water system.
   14. Air handling units.
   15. Condensate return units.
   16. Fan-coil units.
   17. Pumps.
   18. Shell and tube heat exchangers.
   19. Terminal units.
   20. Centrifugal inline fans.
   21. Filter pressure gauges.
   22. BCS.
   23. BCS acceptance.
   24. BCS start-up and checkout.
   25. BCS training.
   26. Certified test reports.
   27. Ductwork leakage tests.
   28. Hydrostatic pressure tests.

1.02 QUALITY ASSURANCE

A. Provide a HVAC Performance Verification Supervisor with ten years experience in HVAC contracting. The HVAC Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section. and if applicable, the commissioning process. The HVAC Performance Verification Supervisor shall coordinate and execute the required performance verification activities.

B. The HVAC Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing and balancing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.

C. Refer to ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems and Assemblies, ASHRAE Guideline 1.1-2007, The HVAC+R Technical Requirements for the Commissioning Process, and Guideline 4-2019, Preparation of Operating and Maintenance Documentation for Building Systems. , and Guideline 1.5-2017, The Commissioning Process for Smoke Control Systems.

1.03 PERFORMANCE VERIFICATION RESPONSIBILITIES

A. The HVAC Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein. Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operations and maintenance data, and training as specified herein.

B. HVAC Performance Verification shall take place in three phases. Performance verification requirements for each phase are as follows:

1. Construction Phase:

a. Attend a performance verification scoping meeting and additional such meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The HVAC Performance Verification Supervisor shall coordinate meeting attendance. with the Commissioning Authority.

b. Report in writing to the Commissioning Authority at least as often as performance verification meetings are scheduled, concerning the status of mechanical activities as they affect the performance verification process, the status of each discrepancy identified the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and the proposed resolution and schedule for correction of the deficiency.

c. Provide documentation of installed systems and equipment, and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the. Commissioning Authority.

d. Develop and submit to the Commissioning Authority for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.

e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Commissioning Authority approval for proposed functional test procedures.
g. Prepare a preliminary schedule for performance verification activities, including pipe and duct system pressure and leakage testing, flushing and cleaning, equipment start-up, and testing, adjusting and balancing start and completion, and update the schedule during the construction period, as appropriate. Notify the Commissioning Authority immediately when the performance verification activities not yet performed or not yet scheduled will delay construction.
h. HVAC equipment start-up shall not be initiated until completion of pressure and leakage testing and cleaning as specified in other Sections of Division 23.
i. Provide start-up and prefunctional testing for equipment, including the building control system, and execute the HVAC-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
j. Perform and document start-up and system operational check-out procedures, providing a copy to the Commissioning Authority.
k. Correct noncompliance items before beginning functional performance testing. Air and water testing, adjusting and balancing shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

2. Acceptance Phase:
   a. Place equipment and systems into operation and continue their operation during each working day of the testing, adjusting and balancing, and performance verification activities, as required.
   b. For each system or area, have required prefunctional checklists, calibrations, start-up and prefunctional tests of the mechanical systems and associated controls completed prior to beginning the testing, adjusting and balancing process.
   c. Provide sheaves and belts as required to achieve required equipment performance, as measured by the testing, adjusting and balancing work.
   d. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
   e. Perform functional testing for specified equipment and interpret the test data, as necessary. under the direction of the Commissioning Authority.
   f. Correct deficiencies (differences between specified and observed performance) as identified by the HVAC Performance Verification Supervisor, or the Commissioning Authority and interpreted by the Engineer and retest the equipment, as required to demonstrate proper operation and performance.
   g. Prepare operation and maintenance manuals as specified herein, including clarifying and updating the original sequences of operation to as-built conditions.
   h. Maintain marked-up record drawings and produce final record drawings of Project drawings and contractor-generated coordination drawings. List and identify on these record drawings the locations of control system components, airflow stations, and sensor installations that are not equipment mounted.
   i. Provide specified training of the Owner's operating personnel.
   j. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

3. Warranty Period:

a. Execute seasonal or deferred functional testing.
b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional testing shall be provided for the equipment or system being tested.

B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
1. Temperature sensors and digital thermometers shall have a certified calibration within the past 12 months and a resolution of ±0.1ºF. Accuracy of temperature test equipment shall be at least twice that of the instrumentation being tested.
2. Humidity sensors shall have a certified calibration within the past 6 months and a resolution of ±1%. Accuracy of humidity test equipment shall be at least twice that of the instrumentation being tested.
3. Pressure sensors shall have a certified calibration within the 12 months and a resolution of 0.05% of sensor range. Accuracy of pressure test equipment shall be at least twice that of the instrumentation being tested.
4. Accuracy of other sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.02 START-UP PLAN AND PREFUNCTIONAL TESTING

A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.

B. Procedures for performance verification shall include:
1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be performance verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
b. First-run checklist for equipment, including:

1) Equipment properly set.
2) Alignment of shafts and couplings.
3) Adjustment of vibration isolators.
4) Piping and equipment properly connected.
5) Completion of initial lubrication procedures.
6) Clean filters in place, as appropriate.
7) Wiring properly connected.
8) Electrical overload relays appropriate for load.
9) Electrical accessories properly installed and adjusted.
10) Controls, safeties, and time switches properly set.
11) Verification of direction of motor rotation after final electrical connections by jogging motor.
12) Verification of proper belt tension.
13) Measurement of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
14) Monitoring of temperature build-up in motors and bearings.

c. Contractor-developed prefunctional checklists.

3. Identify which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.

C. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Commissioning Authority in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures. The Commissioning Authority shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.

D. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for the system. This requirement may be met during the prefunctional testing of the building control system, but shall also be documented with the functional testing procedures.

E. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Commissioning Authority for review. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Commissioning Authority shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.

F. Complete start-up and prefunctional testing for a system before functional test of that system may proceed.

G. Do not operate HVAC systems in a mode that would induce unconditioned, humid outside air into the building.

3.03 RETESTING OF EQUIPMENT AND/OR SYSTEMS

A. Provide labor and materials required for retesting of any functional test found to be deficient.

B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Commissioning Authority for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed

and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.04 DEFERRED TESTING

A. Schedule and coordinate, with the approval of the Commissioning Authority, any required seasonal testing, tests delayed until building construction is completed, required building occupancy or loading, weather, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing. Adjustments or corrections to the operations and maintenance manuals and as-built documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

3.05 SEASONAL ADJUSTMENTS

A. The HVAC Performance Verification Supervisor shall schedule, coordinate and complete the seasonal adjustment process. During this effort the HVAC Performance Verification Supervisor shall:
   1. Check and verify the calibration of temperature control devices and thermostats. Test and verify control sequences for proper operation for the season.
   2. Check the operation, performance, and balance of air and hydronic systems to provide uniform distribution and comfort conditions.

B. Where deficient operation or defective equipment is discovered, provide corrective measures.

3.06 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS

A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. The functional test procedure forms and any outstanding deficiencies shall be provided to the Owner Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing documentation and shall submit either a noncompliance report or an approval form to the Contractor. Work with the Commissioning Authority to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in a timely manner, and notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and deficiencies are identified, work with the Commissioning Authority to resolve the issues.

3.07 OPERATION AND MAINTENANCE MANUALS

A. The HVAC Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in Division 23 and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.08 INSTRUCTION OF OPERATING PERSONNEL

A. The HVAC Performance Verification Supervisor shall schedule, coordinate and assemble, and deliver the documentation of training required by Division 23.

3.09 FUNCTIONAL TESTS

A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the HVAC Performance Verification Supervisor. Execution of these test and demonstration of the required performance shall be the responsibility of the Contractor. under the direction of the Commissioning Authority.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the. Commissioning Authority. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.

C. Functional testing shall be completed and test documentation approved by the Commissioning Authority before the Project is finally accepted.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with 10 CFR Part 431 for Integral Horsepower Motors.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

D. Motors indicated on the drawings as being controlled by variable frequency drives shall be provided with factory-installed shaft grounding rings, which shall consist of a circumferential ring of conductive microfibers that discharge shaft voltages to ground.
   1. Manufacturer: Aegis SGR.

E. The following manufactures are approved:
   a. Baldor Super-E EM/XE with cast iron frames
   b. TECO/Westinghouse ASHH or Max-PE
   c. WEG W22
   d. Toshiba

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. For motors 1 hp and larger
   1. Motor frames and end-bells shall be cast iron for motors 1 hp and larger. Rolled steel frames and aluminum end bells are not acceptable.
   2. Specify premium efficiency motors, as defined by NEMA MG-1, for all motors 1 hp and larger.
   3. Belt drives shall be equipped with fixed pitch sheaves.

D. Insulation shall be a minimum of NEMA class F with Class B temperature rise.

E. Motor service-factors shall be a minimum of 1.15 in an ambient temperature of 40 °C maximum.

F. Motors ½ hp and larger shall be served by three phase electrical service. Provide single phase protection for multiphase motors. For motors ½ hp and larger, provide 480 VAC power when available.

G. Enclosures for motors shall have hinged covers. Bolt on covers are not acceptable.

H. For frames 284 or larger, bearings shall be capable of lubrication. Extend grease lines to an accessible location. For frames 140T - 280T, bearings shall be capable of lubrication or equipped with double shields. Fractional horsepower motors may have sealed bearings.

I. Base plates for motors shall be constructed to NEMA standards and shall have a minimum of 2 belt tensioning bolts.

J. Terminations for motors 5 hp or greater shall made with split bolts wrapped with a layer of glass tape and then black electrical tape.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide with factory-installed shaft grounding rings, which shall consist of a circumferential ring of conductive microfibers that discharge shaft voltages to ground.
6. Provide internal motor space heaters for motors located outdoors which energize upon motor shutdown to prevent internal motor condensation.

2.05 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.06 VFD LOADSIDE WIRING

A. Acceptable load-side wiring:
1. Individual conductors
2. Approved VFD cable

B. Conductor insulation
1. The use of THHN wire is prohibited.

C. Shielding
1. The power conductors and primary ground conductors shall be encased in a continuous electrical shield.
2. The ends of the shielding system shall be grounded to the VFD ground bar and the motor conduit box.
3. Shielding shall be provided by either metallic raceway or shielded VFD cable.
4. When utilizing metallic raceways as the shield, continuous shield continuity shall be provided between the terminations at each end. To maintain continuous continuity, raceway components shall be connected with grounding bushings, grounding straps or other wiring techniques.
5. Bonding of primary ground conductors to the shield system is prohibited except at the VFD ground bar and motor. Ground conductors shall not be bonded to load-side junction boxes.

D. Grounding
1. Two separate grounds shall be provided.
2. The primary ground is shielded (as described above) and is installed between the VFD ground bar and the motor ground termination. The shield is bonded to the ground at both ends.
3. A secondary ground is required and will be installed to bond the motor frame or skid framing to the building ground system such the ground bar within a panel or building steel. When using the skid as the ground termination, the motor frame shall be bonded to the skid. The secondary ground system may daisy chain between multiple motors and skids.
4. The minimum size of the primary grounding conductions shall be the same size as the power conductors. For 25 hp and larger, the ground conductors shall be a minimum of 200% of the load conductors, i.e. two full size ground conductors or equivalent. For 40 hp and larger, the ground conductors shall be a minimum of 300% of the load conductors, i.e. three full size ground conductors or equivalent.
5. The primary ground conductors must not have intermediate connections to the shield system such as at junction boxes. (Note: if in doubt to what this means, inquire with Engineering Services)

E. VFD Cable:
1. Cable shall have low capacitance and impedance design.
2. VFD cables shall be terminated per the manufacture’s installation instructions.
3. Cables shall meet or exceed 600V UL 1277 Type TC-ER, 1000V UL 2277 Type WTTC, IEEE 1202.
4. VFD cable conductors shall be XHHW-2 or RHW-2 circuit conductors rated at 90 ‘C wet/dry.
5. Cables with armor such as stainless-steel braid, may be installed outside of a raceway, but cables installed in air plenums shall be enclosed in raceway or shall be plenum rated.
6. Basis of Design: Less than 40 hp - Belden Classic VFD Cable. Greater than 40 hp- Belden Symmetrical Classic VFD cable. Other brands may be considered.

PART 3 - EXECUTION

A. VFD cable ground wires, drain wires, shielding and armor shall only be grounded at the VFD and the motor. Any of the above ground system must NOT be bonded to disconnects and will be isolated from disconnects with cable insulation, shrink wrap, or other approved meansCables shall be equipped with a PVC or equivalent jacket.

F. VFD conductors shall be constructed from fine, tinned copper strands.

G. Cables with 2 AWG and smaller conductors shall be equipped with a braided armor and copper foil shield. Cables larger than 2 AWG shall have a minimum of copper foil shielding.

H. Inspections:
   1. Each contractor installing VFD to motor wiring shall schedule and conduct a special inspection for the (Owner or CxA) to inspect a minimum of one, complete VFD to motor wiring installation.
   2. The inspector will select the specific installation to be inspected.
   3. The contractor shall make visible for inspection the terminations at the VFD, at the motor, at any intermediate junction boxes and the terminations of the secondary ground system. The contractor shall open devices as needed to complete the inspection.

END OF SECTION

SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Packed expansion joints.
2. Alignment guides and anchors.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.02 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Mason Industries, Inc.
d. Metraflex Company (The).
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
a. Stud: Threaded, zinc-coated carbon steel.
b. Expansion Plug: Zinc-coated steel.
c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.01 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

B. Related Requirements:
1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low emitting materials.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Manufacturers: Subject to compliance with requirements, undefined:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.02 STACK-SLEEVE FITTINGS

A. Description: Manufactured, galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.03 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, undefined:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Description:
1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.05 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.06 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. GE Construction Sealants; Momentive Performance Materials Inc.
b. Pecora Corporation.
c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
2. Verify sealant has a VOC content of 250 g/L or less.
3. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
1. Verify sealant has a VOC content of 250 g/L or less.
2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
1. Verify sealant has a VOC content of 250 g/L or less.
2. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.02 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated, Horizontal Assembly, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeve-seal fittings.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.06 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls Above Grade:
   a. Piping Smaller Than NPS 6 : Sleeve-seal fittings.
   b. Piping NPS 6 and Larger: Sleeve-seal fittings.
2. Exterior Concrete Walls Below Grade:
   a. Piping Smaller Than NPS 6 : Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6 : Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs Above Grade:
   a. Piping Smaller Than NPS 6 : Steel pipe sleeves
   b. Piping NPS 6 and Larger: Steel pipe sleeves.
5. Interior Partitions:
   a. Piping Smaller Than NPS 6 : Steel pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.03 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.02 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping and Relocated Existing Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
      b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
      c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
      d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
      e. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
      f. Insulated Piping: One-piece stamped steel or split-plate, with polished, chrome-plated finish.
      g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
      h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
      i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.

j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
s. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.
t. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:
a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.02 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 23 05 19 - GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Test plugs.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. Weksler Glass Thermometer Corp.
2. Standard: ASME B40.200.
3. Case: Cast aluminum ; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.03 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. WATTS.
   c. Weiss Instruments, Inc.
   d. Weksler Glass Thermometer Corp.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Brass.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.04 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trerice, H. O. Co.
2. WATTS.
3. Weiss Instruments, Inc.
4. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Hydronic pressure gauges exposed to vibrations or condensation shall be liquid filled.

B. When providing pressure measurement on each side of equipment, provide a single gauge connected to both sides and equipped with isolation valves for measuring either side independently with the same gauge.

C. For heat exchangers, install hydronic pressure gauges to allow for measurement of the differential pressure across the tubes and across the strainer. Install isolation valves on each sensing line. Hydronic pressure gauges are not required across reheat coils or coils under 60 k BTU.

D. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

E. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

F. Install thermowells with extension on insulated piping.

G. Fill thermowells with heat-transfer medium.

H. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

I. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

J. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

K. Install remote-mounted pressure gages on panel.

L. Install valve and snubber in piping for each pressure gage for fluids (except steam).

M. Install valve and syphon fitting in piping for each pressure gage for steam.

N. Install test plugs in piping tees.

O. Install flow indicators in piping systems in accessible positions for easy viewing.

P. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

Q. Install permanent indicators on walls or brackets in accessible and readable positions.

R. Install connection fittings in accessible locations for attachment to portable indicators.

S. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic coil in air-handling units.
   3. Two inlets and two outlets of each hydronic heat exchanger.
   4. Outside-, return-, supply-, and mixed-air ducts.

T. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
   3. Suction and discharge of each pump.

3.02 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

B. Connect thermal-energy meter transmitters to meters.

3.03 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 23 05 23.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Steel ball valves.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

C. SWP: Steam working pressure.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. ASME B16.5 for flanges on steel valves.
   2. ASME B1.20.1 for threads for threaded-end valves.
   3. ASME B16.18 for cast copper solder-joint connections.
   4. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
   5. ASME B31.9 for building services piping valves.

B. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Hand Lever: For quarter-turn valves smaller than NPS 4.

E. Valves in Insulated Piping:
   1. Provide 2-inch extended neck stems.
   2. Extended operating handles with nonthermal-conductive covering material, and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Threaded or Soldered Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
      d. WATTS.
   2. Standard: MSS SP-110.
   3. Pressure Rating: 250 pisg at 100F
   4. Body Design: Two piece.
   5. Body Material: Bronze.
   6. Ends: Threaded or soldered.
   7. Seats: PTFE.
   8. Stem: Stainless steel.
   9. Ball: Stainless steel, vented.
   10. Port: Full.

2.03 STEEL BALL VALVES

A. Steel Ball Valves, Two Piece with Full Port and Stainless Steel Trim, Flanged Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane.
      b. Edwards,
      c. Jenkins.
      d. Lunkenheimer.
      e. Milwaukee.
      f. Powell.
      g. Walworth.
      h. Williams.
   2. Standard: MSS SP-72.
   3. Pressure Rating: 250 pisg at 450F
   4. Body Design: Two piece.
   5. Body Material: Carbon steel.
   6. Ends: Flanged.
   7. Seats: R-PTFE.
   8. Stem: Stainless steel.
   9. Ball: Stainless steel
   10. Port: Full.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.02 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, provide the same types of valves with higher SWP classes or CWP ratings.

B. Select valves with the following end connections:
1. For Tubing, NPS 2-1/2 and Smaller: Threaded ends except where solder-joint valve-end option.

3.05 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Smaller: bronze ball valves, two piece, with stainless steel trim, full port, and solder -joint ends.

3.06 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Smaller: bronze ball valves, two piece with stainless steel trim, full port, and solder -joint ends.

3.07 STEAM-CONDENSATE VALVE SCHEDULE

A. Steam Condensate Strainer Blow-Down Isolation: Class 600 Steel ball valves, two piece with stainless steel trim, full port, and flanged ends.

B. Steam Pressure Gauge Isolation: Class 600 Steel ball valves, two piece with stainless steel trim, full port, and flanged ends.

END OF SECTION

SECTION 23 05 23.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. High-performance butterfly valves.
   2. Chainwheels.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: ABS, Buna-N, or nitrile butadiene rubber.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B16.5 for flanges on steel valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B31.1 for power piping valves.
   5. ASME B31.9 for building services valves.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Gear Actuator: For valves NPS 8 and larger.
   2. Hand Lever: For valves NPS 6 and smaller.
   3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Installation of Valves" Article.

D. Valves in Insulated Piping: Provide with 2-inch extended neck stems.

2.03 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange (Lug-Type) High-Performance Butterfly Valves, Class 300:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.

b. Bray International, Inc.
c. DeZURIK.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Siemens.

2. Standard: MSS SP-68.
3. CWP Rating: 720 psig at 100 deg F.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: Carbon steel.
6. Seat: Reinforced EPDM and peroxide cured EPDM on hot water systems.
7. Stem: Stainless steel; offset from seat plane.
8. Disc: Type 316 stainless steel.
9. Service: Bidirectional.

2.04 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries; Rotork.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.
1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.02 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Install chainwheels on manual actuators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Valve Tags: Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. If leakage cannot be repaired, replace valve.

3.04 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Single flange, carbon-steel body, and Class 300.

3.05 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Single flange, carbon-steel body, and Class 300.

END OF SECTION

SECTION 23 05 23.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bronze swing check valves.
   2. Iron swing check valves.
   3. Stainless steel swing check valves.

1.02 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. NBR: Nitrile butadiene rubber (also known as "Buna-N").

D. SWP: Steam working pressure.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, press connections, and weld ends.
   3. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for cast copper solder joint.
   5. ASME B16.22 for wrought copper solder joint.
   6. ASME B31.1 for power piping valves.
   7. ASME B31.9 for building services piping valves.

B. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.03 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Valves; a Crane Co. brand.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Stockham; a Crane Co. brand.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.04 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 250:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Valves; a Crane Co. brand.
c. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.05 STAINLESS STEEL SWING CHECK VALVES

A. Stainless Steel Swing Check Valves with Metal Seats, Class 300:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Valves; a Crane Co. brand.
c. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-110.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Stainless steel.
g. Gasket: Graphite and stainless steel core.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. Install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:
1. Swing Check Valves: In horizontal position with hinge pin level.
2. Check Valves: In horizontal or vertical position, between flanges.

I. Install valve tags. Comply with requirements for valve tags and schedules in Section 23 05 53 "Identification for HVAC Piping and Equipment."

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's recommended maximum.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Pump-Discharge Check Valves:
a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. End Connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends, except where solder-joint option is indicated in valve schedules.
2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 150.

B. Pipe NPS 2-1/2 and Larger:
1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 6 and larger: Flanged ends
3. Iron swing check valves with metal seats, Class 250.

3.06 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 150.

B. Pipe NPS 2-1/2 and Larger:
1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. NPS 6 and larger: Flanged ends
3. Iron swing check valves with metal seats, Class 250.

3.07 STEAM VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Stainless steel: NPT.
2. Stainless steel swing check valves with stainless steel disc, Class 600.

B. Pipe NPS 2-1/2 and Larger:
1. NPS 2-1/2 to NPS 4: Stainless steel valves may be provided with welded ends instead of flanged ends.
2. NPS 6 and larger: Welded ends.
3. Stainless steel swing check valves with stainless steel seats, Class 300.

END OF SECTION

SECTION 23 05 23.15 - GATE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Iron gate valves.
2. Steel gate valves.
3. Chainwheels.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.02 GATE VALVES

A. Iron Gate Valves, NRS, Class 300:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Valves.
      b. Edwards.
      c. Jenkins.
      d. Lunkenheimer.
      e. Milwaukee.
      f. Powell.
      g. Walworth.
      h. Williams.
   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Welded.
      f. Trim: Stainless steel.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.

B. Iron Gate Valves, OS&Y, Class 300
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Valves.
      b. Edwards.
      c. Jenkins.
      d. Lunkenheimer.
      e. Milwaukee.
      f. Powell.
      g. Walworth.
      h. Williams.
   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Welded.
      f. Trim: Stainless Steel.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.

C. Steel Gate Valves, OS&Y, Class 600
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Valves.
      b. Edwards.
      c. Jenkins.
      d. Lunkenheimer.
      e. Milwaukee.
      f. Powell.
      g. Walworth.
      h. Williams.
   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 2 to NPS 12, CWP Rating: 500 psig.

c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Material: ASTM A217.
e. Ends: Welded.
f. Trim: Stainless Steel.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free graphite.

2.03 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, undefined:
1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries; Rotork.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.
1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve.
2. Chain: Hot-dip-galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for gate valves NPS 6 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install valve tags. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
1. Shutoff Service: Gate valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules below.
   2. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS OS&Y, Class 300.

3.06 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG

A. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS OS&Y, Class 300.

3.07 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger: Iron gate valves, NRS OS&Y, Class 300.

B. Condensate Pump Discharge Isolation Valve: Steel gate valve, OS&Y, Class 600.

C. Main Condensate Return Isolation Valve: Steel gate valve, OS&Y, Class 600.

D. Steam Trap Assembly Upstream of PRV Isolation Valves: Steel gate valve, OS&Y, Class 600.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment stands.

B. Related Requirements:
1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 23 31 13 "Metal Ducts" for duct hangers and supports.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
2. Equipment supports.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

2.02 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.04 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckaroos, Inc.
2. CADDY; brand of nVent Electrical plc.
3. Carpenter & Paterson, Inc.
4. National Pipe Hanger Corporation.
5. Pipe Shields Inc.
6. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.
2. Indoor Applications: Zinc-coated or stainless steel.
3. Outdoor Applications: Stainless steel.

2.06 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.02 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting"and "Section 09 91 23 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.07 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and and attachments for general service applications.

F. Use stainless steel or corrosion-resistant attachments for hostile environment applications.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   4. C-Clamps (MSS Type 23): For structural shapes.
   5. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   6. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
   7. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
      a. Light (MSS Type 31): 750 lb.
      b. Medium (MSS Type 32): 1500 lb.
      c. Heavy (MSS Type 33): 3000 lb.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 33 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes heat tracing for HVAC piping with the following electric heating cables:
   1. Self-regulating, parallel resistance.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers
   1. Chromalox
   2. Raychem
   3. Thermon

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:
   1. Maximum Heat Output: Refer to Drawings
   2. Piping Diameter.
   3. Spiral Wrap Pitch.
   4. Electrical Characteristics for Single-Circuit Connection:
      a. Volts: 120
      b. Phase: 1
      c. Hertz:.60

2.02 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.

B. Install electric heating cables after piping has been tested and before insulation is installed.

C. Install electric heating cables according to IEEE 515.1.

D. Install insulation over piping with electric cables according to Section 23 07 19 "HVAC Piping Insulation."

E. Install warning tape on piping insulation where piping is equipped with electric heating cables.

F. Set field-adjustable switches and circuit-breaker trip ranges.

3.03 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.04 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Neoprene Isolation Washers and Grommets
4. Open-spring isolators.
5. Restrained-spring isolators.
6. Pipe-riser resilient support.
7. Resilient pipe guides.
8. Elastomeric hangers.
9. Spring hangers.
10. Precompressed Spring Hangers
11. Manufactured Pipe Isolation Hangers
12. Field Assembled Pipe Isolation Hangers
13. Snubbers.
14. Restraints - rigid type.
15. Restraints - cable type.
16. Restraint accessories.
17. Post-installed concrete anchors.
18. Concrete inserts.
19. Vibration isolation equipment bases.
20. Restrained isolation roof-curb rails.
21. Elastomeric Curb Isolation
22. Flexible Connections
23. Thrust Restraints

B. Related Requirements:
1. Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.03 DEFINITIONS

A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include vibration isolation mounts and hangers, including isolator data, manufacturer's equipment operating weight, actual load distribution and actual static deflection at each loading point for each piece of isolated equipment.
2. Include equipment base details including dimensions, structural member size, and support point locations.
3. Include flexible duct and pipe connector data sheets including manufacturer's ratings for pressure and temperature.
4. Include load rating for each wind-force-restraint fitting and assembly.

5. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic and wind-force restraint component.
6. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [ICC-ES product listing] [UL product listing] [FM Approvals] [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction].
7. Annotate to indicate application of each product submitted and compliance with requirements.
8. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Shop drawings for piping isolators shall be made on prints of the piping shop drawings.

C. Delegated-Design Submittal:
1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:
   a. Seismic and Wind-Load Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
   b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
   c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
   d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
   e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
   f. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic and Wind Restraint Detail Drawing:
   a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By [an evaluation service member of ICC-ES] [UL] [FM Approvals] [OSHPD] [an agency acceptable to authorities

having jurisdiction], showing maximum ratings of restraint items and basis for approval (tests or calculations).

5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-10 Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or ASCE/SEI 7-10.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

F. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic- and Wind-Load Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a

listing directory available to the public. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic and wind load control system.

B. Seismic Design Calculations:
1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-10 including supplement No. 1. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
a. Data indicated on the Drawing schedules to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

C. Wind-Load Design Calculations:
1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-10. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
a. Data indicated in the Drawing schedules that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

D. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.

E. Fire/Smoke Resistance: Seismic and wind-load restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:
1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-10 Section 13.6.

2.02 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: NP.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Ribbed or waffled on both sides.
6. Minimum thickness 0.75 inches.
7. Load-bearing metal plates adhered to pads as recommended by isolation pad manufacturer for loading conditions.

2.03 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: DN.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Mounting Plates:
a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.04 NEOPRENE ISOLATION WASHERS AND GROMMETS

A. Neoprene Isolation Washers and Grommets: IWG.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Neoprene isolation washer and grommets shall have a nominal durometer of Shore 50A.

2.05 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: FS.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Unhoused combination spring with neoprene type.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplate shall limit floor load to 500 psig.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.06 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: LS.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
a. Base shall limit floor load to 500 psig.
b. Internal leveling bolt that acts as blocking during installation.
3. Combination spring and neoprene type.
4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
a. Limit stops shall be out of contact with the housing during normal operation.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.07 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- Thick Neoprene: NA.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mounting & Controls, Inc.
2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.08 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- Thick Neoprene: NR.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.09 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: NH.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.10 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: SH.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.11 PRECOMPRESSED SPRING HANGERS

A. Precompressed Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: PSH.
1. Shall meet all of the specified requirements of Type SH spring hangers.
2. Shall be provided precompressed by the manufacturer to the rated deflection. Hanger shall have a release mechanical to free the spring after installation is complete.

2.12 MANUFACTURED PIPING ISOLATION HANGER

A. Pipe Hanger Manufactured With Elastomeric Vibration Isolation Layer: PIM.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. HoldRite
b. Elmdor Stoneman
c. F&A Products, Inc.
2. Elastomeric Layer: 30-50 durometer ribbed neoprene, thermoplastics rubber, or crumb rubber.
3. Inside diameter sized for piping outside diameter.

2.13 FIELD ASSEMBLED PIPING ISOLATION HANGER

A. Field Assembled Piping Isolation Hanger Treatment: PIF.
1. 1/2" thick closed cell elastomeric foam insulation layer installed between the pipe and hanger.
2. Minimum 3" wide strip or as required to provide 1" overhang on each side of support pipe.
3. Oversize pipe hangers by a minimum of 3/4" to prevent crushing of foam insulation.
4. Multiple layers of closed cell insulation may be used to reach the required thickness.
5. Closed cell foam insulation to be Armacell AP or Equal.

2.14 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Eliminator Co., Inc.
4. Vibration Mountings & Controls, Inc.
5. Vibro-Acoustics.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.15 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mountings & Controls, Inc.
8. Vibro-Acoustics.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.16 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mountings & Controls, Inc.
8. Vibro-Acoustics.

B. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.17 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mounting & Controls, Inc.
8. Vibro-Acoustics.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.18 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. DeWALT.
b. Hilti, Inc.
c. Simpson Strong-Tie Co., Inc.
2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. DeWALT.
b. Hilti, Inc.
c. Simpson Strong-Tie Co., Inc.
2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-10, Ch. 13.
   1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
   2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
   1. Undercut expansion anchors are permitted.

2.19 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. DeWALT.
   2. Gripple, Inc.
   3. Hilti, Inc.
   4. International Seismic Application Technology (ISAT).
   5. Simpson Strong-Tie Co., Inc.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

2.20 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Kinetics Noise Control, Inc.
   2. Mason Industries, Inc.
   3. Vibration Eliminator Co., Inc.
   4. Vibration Mountings & Controls, Inc.
   5. Vibro-Acoustics.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails: SR.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails: SB.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete: CIB.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
5. The weight of each inertia base shall be sufficient to lower the center of gravity to or below the isolator support plane for installations with seismic or wind loading requirements. For non-seismic and non-wind loaded conditions weight of each base shall be at least equal to the weight of the equipment mounted thereon.
6. Inertia bases shall be a minimum of 6" thick.

2.21 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Spring Isolation Curbs: SC.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Eliminator Co., Inc.
4. Vibration Mountings & Controls, Inc.
5. Vibro-Acoustics.

C. Description: Factory-assembled, fully enclosed, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

D. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist seismic and wind forces.

E. Lower Support Assembly: Containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure or a wood nailer for attaching roof materials, and to be insulated as required of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.

F. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

G. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past lower support assembly, and counterflashed over roof materials.

2.22 ELASTOMERIC CURB ISOLATION

A. Elastomeric Curb Isolation Pad: ECIP.
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Description: Elastomeric curb isolation pad installed between roof mounted equipment and supporting curb.
3. Minimum 0.5" elastomeric layer thickness.
4. Minimum 1.75" elastomeric layer width.
5. 40-60 durometer neoprene or high density compressed molded fiberglass individually coated with a flexible moisture impervious membrane.
6. Elastomeric layer surface finish shall allow a weather proofed seal at top and bottom joint.
7. Adhered to curb and equipment with mastic adhesive without need of rigid connection. Sealed weather tight at all joints with silicone caulk.

2.23 FLEXIBLE CONNECTORS

A. Flexible Elastomeric Pipe Connectors
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Single-sphere and twin-sphere types, made of multiple plies of nylon cord fabric and neoprene, hydraulically molded.
3. Connectors through 1.5" shall have threaded ends. Connectors 2" and large shall have flanged ends with recessed groove to receive the connector's raised neoprene face.
4. Connectors 4" and larger operating above 100 psig, and any sizes and pressures as required by flex connector manufacturer, shall have isolated limit stops to prevent overextension and overcompression.
5. Limit stops shall be either control cables with neoprene isolated end fitting and anti-compression stops, control rods with neoprene isolation washers and bushings, or spring isolated control units.
6. Connectors shall be line size and shall be designed for the pressures and temperatures encountered in the system, minimum 150 psig and 250° F.

B. Flexible Metal Hose Connectors
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.
2. Stainless steel corrugated type with stainless steel woven braid outer sheath.
3. Minimum Live Lengths:
a. Pipe diameters up to 2.5" - 12" minimum live length.
b. Pipe diameters 3" to 4" - 18" minimum live length.
c. Pipe diameters 5" to 10" - 24" minimum live length.
d. Pipe diameters 12" or greater - 36" minimum live length.

C. Flexible Duct Connector
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Duro-Dyne.
c. Ventfabrics.
2. Fabric, fiberglass, or EPDM flexible connections.
3. Connections shall comply with NFPA 90A-2018, NFPA 701-2019, adn shall be asbestos-free and designed for continuous use at 275° F.
4. Connections to laboratory exhaust equipment shall be designed for use with acidic fumes.
5. Connections exposed to weather shall be sunlight and ozone resistant.
6. Flexible sections shall be wide enough to allow at least 2" of flexible separation in installed conditions.

2.24 THRUST RESTRAINTS

A. Spring Thrust Restraints
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.

c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.

2. A set (2 or more per installation location) of spring thrust resisting assemblies consisting of coil springs, spring retainers, isolation washers, angle mounting brackets, and elastomeric tubing for isolating thrust rods.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.03 INSTALLATION OF VIBRATION-CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawing Plans, General Notes, Schedules, and/or Details, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Installation of vibration isolators wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint, and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

H. Install seismic and wind-load restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Mechanical Anchor Bolts:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7.

3.05 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.06 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Stencils.
7. Valve tags.
8. Warning tags.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Brady Corporation.
b. Brimar Industries, Inc.
c. Craftmark Pipe Markers.
d. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/2 inch for name of units if viewing distance is less than 24 inches, 1 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.02 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/2 inch for name of units if viewing distance is less than 24 inches, 1 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Seton Identification Products; a Brady Corporation company.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 4 inches.

2.04 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.

F. Lettering Size: Size letters in accordance with ASME A13.1 for piping. Lettering size shall be roughly 1/3 to ½ the diameter of the pipe including insulation.

2.05 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Carlton Industries, LP.
   4. Champion America.
   5. Craftmark Pipe Markers.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:
   1. Duct size.
   2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
   3. Lettering Size: Size letters in accordance with ASME A13.1 for piping. Approximately 2" in height

2.06 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Seton Identification Products; a Brady Corporation company.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass beaded chain.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Include valve-tag schedule in operation and maintenance data.

2.07 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. Brimar Industries, Inc.
   3. Craftmark Pipe Markers.
   4. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.02 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.03 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. B. Equipment shall be clearly identified with engraved plastic plates securely fastened to the equipment with sheet metal screws. Phenolic plates with tag and letter colors in compliance with the SCO electrical design guidelines. Indicate the equip ID number. Indicate at the fan/s and the equipment served or system served, panel number, and breaker number

C. Concealed equipment: All equipment requiring periodic maintenance or testing located in concealed spaces shall be clearly identified on an adjacent finished surface to identify the location of equipment. For equipment mounted above ceilings, provide an ID label on the ceiling below the equipment. Typical concealed equipment includes air terminals, air valves, PRVs, mixing valves, duct and pipe differential pressure sensors, steam traps, fire smoke dampers, etc. Labels shall be clear or white with 0.375" high black letters affixed to the ceiling.

3.04 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.05 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Within 3 ft. of each valve and control device.
   2. At access doors, manholes, and similar access points that permit view of concealed piping.
   3. Within 3 ft. of equipment items and other points of origination and termination.
   4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:
1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
3. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.
4. Low-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
5. Steam Condensate Piping: Black letters on an ANSI Z535.1 safety-yellow background.

3.06 INSTALLATION OF DUCT LABELS

A. Install plastic-laminated duct labels showing service and flow direction with permanent adhesive on air ducts.
1. Provide labels in the following color codes:
a. For air supply ducts: White letters on blue background.
b. For air return ducts: White letters on blue background.
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
d. For kitchen exhaust: White letters on a blue background.
e. For make-up air: White letters on a blue background.
2. When accessible, identify exhaust duct at each floor level and at roof level with the exhaust fan ID and device served or exhaust system name

B. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

3.07 SYSTEM PAINTING SCHEDULE

A. Completely paint piping systems or utilize colored PVC jackets in mechanical rooms with the applicable colors listed below.

B. Ductwork:
1. Color - None
2. System Abbreviation - Supply, Exhaust, Return

C. Chilled Water Supply:
1. Color - Dark Blue/Light Blue
2. System Abbreviation – CWS

D. Chilled Water Return:
1. Color - Dark Blue/Light Blue
2. System Abbreviation - CWR

E. Heating Hot Water:
1. Color - Orange/Yellow
2. System Abbreviation - HWS / HWR

F. Low Pressure Steam:
1. Color - Dark Red
2. System Abbreviation - LPS

G. Steam Condensate Return:
1. Color - Tan
2. System Abbreviation - LPSC

3.08 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
   1. Valve-Tag Size and Shape:
      a. Chilled Water: 1-1/2 inches, round.
      b. Hot Water: 1-1/2 inches, round.
      c. Low-Pressure Steam: 1-1/2 inches, round.
      d. Steam Condensate: 1-1/2 inches, round.
   2. Valve-Tag Colors:
      a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.
      b. Mark the tags with the following: equipment or branch served, design gpm, installed CV, fail position (FC, FO, FLP), installation date, and installer's name/company. When applicable, provide other key information such as measured differential pressure or valve characteristic.
   3. Balance Damper Identification:
      a. Balance dampers shall be identified and labeled.
      b. For ease of locating the balance dampers, orange survey ribbon shall be hung from unexposed balance dampers such as when above ceilings or in chases.
      c. Balance damper shall be labeled with the following information on a vinyl tag, permanent adhesive label, or other approved means: design flowrate, final set position, date, balancers name/company.
   4. Balance valves identification:
      a. Balance valves shall be tagged with vinyl or other approved tags that will last the life of the valve.
      b. Mark the tags with the following: equipment or branch served, design gpm, final set position (if applicable), final measured differential pressure, date, and TAB contractor name
      c. The following should also be notated on the tag: balance valve brand and model, measured pressure drop at design flow, when applicable, installed cartridge or orifice size.
   5. Isolation Valve Identification
      a. Isolation valves shall be clearly identified in the design drawings on both the pipe layout drawings and the pipe schematic drawings.
   6. Expansion and hydropneumatics tanks: Identify the final set pressure on the tank. This may be done with a vinyl maintenance tag or other permanent means.

3.09 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Testing, Adjusting, and Balancing of Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
   a. Variable-flow hydronic systems.
3. Testing, adjusting, and balancing of steam and condensate piping systems.
4. Testing, adjusting, and balancing of equipment.
5. Duct leakage tests verification.
6. Pipe leakage tests verification.

1.03 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.04 ACTION SUBMITTALS

A. Sustainable Design Submittals:
1. Air-Balance Report: Documentation indicating that Work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

C. Certified TAB reports.

D. Sample report forms.

E. Instrument calibration reports, to include the following:
1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.06 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:
1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB :
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
   1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

F. Balance devices shall be equipped with tags, labels and markings recording the following: design flowrate, final setting position, pressure drop when equipped with flow orifices, date of final setting, and TAB Company name. Duct balance damper handles shall be marked with survey tape.

G. Air and water systems shall be tested including all ducts and fire dampers.

1.07 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Final Acceptance. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. At least one AABC or NEBB certified balance specialist with a minimum of 2 years’ experience shall be at the site to perform daily TAB activities.

B. TAB activities shall be reviewed by a certified TAB supervisor or Professional.

C. Testing and balancing of air systems shall be performed in complete accordance with the latest version of AABC National Standards for Total System Balance, 2002 Edition or NEBB Procedural Standards for TAB Environmental Systems 7th Edition 2005 or subsequent versions.

D. Balance reports shall be sealed as accurate by a professional engineer licensed in the State of North Carolina.

E. The designer shall review and approve the qualifications of the balance specialist and the means and methods of testing.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.

j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning in accordance with the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
1. Motors.
2. Pumps.
3. Fans and ventilators.
4. Terminal units.
5. Unit heaters.
6. Heat exchangers.
7. Air-handling units.
8. Split-system air conditioners.
9. Coils.
10. Fan coil units.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

1. Variable frequency drives shall be set up and tested to verify:
    a. Design conditions:
        1) Verify fan can produce design flow at design total static pressure without overloading the fan motor while operating at, or less than 100% input signal.
    b. Installed conditions:
        1) Verify fan can produce design flow at installed total static pressure without overloading the fan motor while operating at, or less than 100% input signal. Simulate filter loading as needed to establish design filter pressure drop allowance.
        2) Verify after system balance that fan can operate at 100% input signal without overloading fan motor or creating excessive inlet or discharge pressures. Rescale input signal as needed to prevent motor overload or excessive pressures.
2. Balance air handling unit fans that are controlled in parallel such that the fan inlet static pressures and fan discharge static pressures are the same for each air handling unit. The manual dampers and outside air dampers associated with each unit shall be adjusted to equalize those pressures.
3. Balance air handling units such that duct static pressures are maintained as low as possible while maintaining minimum inlet static pressure and airflow requirements at each terminal unit.
4. Total supply, return and outside air airflow for each air handling unit shall be measured using pitot tube duct traverses. Where the outside air inlet configuration is insufficient for a pitot tube duct traverse, the outside air shall be calculated as the difference between the supply and return.
5. Determine the minimum and maximum supply duct static pressure setpoints, as described in the air handling unit controls sequences on the drawings.
6. For air handling units with multiple supply duct static pressure sensors, determine unique supply duct static pressure setpoints for each sensor location.
7. For systems with diversity, with the fan under control and loads nearest the fan distributed throughout the system commanded to minimum flow setpoint to simulate diversity, verify design flow through each terminal unit. Diversity shall be calculated as the ratio of the total system capacity to the total connected load.
8. Adjust pattern adjustment devices in diffusers for horizontal discharge, unless otherwise indicated on the drawings.
9. Calibration of BAS flow elements shall be verified through the use of duct traverses or flow hoods, as appropriate for the device being calibrated. BAS flow elements shall not be used for balance adjustments prior to the verification of their calibration. Use a 3-point calibration method to calibrate terminal units. 3-point calibration for airflow measurement systems that

will experience variable flow, using the lower and upper airflow limits as two of the calibration points.

10. Test, adjust and balance outside air balancing, minimum outside air and return dampers to produce the quantity of minimum outside air indicated on the drawings when the each air handling unit is operating at its maximum supply air quantity. Return air dampers shall be adjusted to a less than fully open position only if required to achieve the minimum outside air quantity indicated on the drawings. Return and minimum outside air damper linkages shall be adjusted to position their respective dampers at full stroke. Permanently mark damper linkage adjustments. Measure, record and adjust the outside air balancing damper differential pressure mixing plenum static pressure setpoints, including associated lower and upper limits, as necessary to achieve the required outside air quantity described in the air handling unit controls sequences on the drawings.
11. For multiple air handling units being controlled in parallel (as indicated in the controls sequences), test, adjust and balance the units for each potential operating condition (i.e., one unit operating, 2 units operating, etc.), and provide unique outside air control setpoints for each condition.
12. Balance and adjust system balancing tolerances (within specified limits) to ensure pressurization of the entire building, and to minimize stack effect during the winter.
13. Balance and adjust individual room air distribution devices balancing tolerances (within specified limits) to achieve pressure relationships indicated on the drawings.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   4. Obtain approval from Architect / Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
      c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
      d. Adjust controls so that terminal is calling for minimum airflow.
      e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
      f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
   5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
      c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   6. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   5. Verify that motor controllers are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
   1. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the pressure-differential sensor(s) is located as indicated.
   2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:
   1. Adjust pumps to deliver total design flow.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.

3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:
1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.
a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:
a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).

7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

8. Mark final settings and verify that all memory stops have been set.

9. Verify final system conditions as follows:
a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

D. For systems with flow diversity:
1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.
a. Measure total water flow.
1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.

3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:
1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.
a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:
a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:
a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.

9. Prior to verifying final system conditions, determine system pressure-differential set point(s).

10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

11. Mark final settings and verify that memory stops have been set.

12. Verify final system conditions as follows:
a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

13. Variable frequency drives for pumps shall be set up and tested to:
a. Design conditions:
1) Verify pump can produce design flow at design total head without overloading the motor while operating at, or less than 100% input signal.

b. Installed conditions:

1) Verify pump can produce design flow at installed total head without overloading the motor while operating at, or less than 100% input signal.
2) Verify after system balance that pump can operate at 100% input signal without overloading motor or creating excessive pressures. Rescale input signal as needed to prevent motor overload or excessive pressures.

14. Operate the system pumps under control and balance terminal devices for design flow with control valves wide open. Record the pump operating data and piping loss data. Do not throttle the pump discharge. Calculate the pump differential pressure setpoint needed to obtain full flow at the worst case load and set the pump controller to that value.
15. Balance pumps that are controlled in parallel such that the pump suction and discharge pressures are the same for each pump. The balancing valve associated with each pump shall be adjusted to equalize those pressures.
16. Balance hydronic systems such that distribution system differential pressures are maintained as low as possible while maintaining the minimum differential pressure and volume requirements at connected loads.
17. For systems with diversity, with the pump under control and loads nearest to the pump closed off to simulate diversity, verify design flow through each terminal device. Diversity shall be calculated as the ratio of the total system capacity to the total connected load.

3.11 PROCEDURES FOR STEAM AND CONDENSATE SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.12 PROCEDURES FOR STEAM-TO-WATER HEAT EXCHANGERS

A. Adjust and record water flow to within specified tolerances.

B. Measure and record inlet and outlet water temperatures.

C. Measure and record inlet steam pressure and condensate outlet pressure.

D. Check and record settings and operation of safety and relief valves.

3.13 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.15 DUCT LEAKAGE TESTS

A. For ductwork with static pressure classification of greater than 4" wg a leakage test shall be made after installation of the first representative sample of ductwork of each classification. The test sample shall incorporate at least: 5 transverse joints, typical seams, one elbow, 2 typical branch connections, and for riser ducts or other systems that include multiple fire dampers, one fire damper and one access door. After satisfactory results for the test sample, additional ductwork shall be tested totaling no less than 25% of the total duct area for each pressure class. Remaining duct sections shall be tested until the total duct area for each pressure class has been tested.

B. Prior to testing, submit drawings indicating sections of ductwork to be tested, including area calculations.

C. Leakage testing shall be performed in accordance with SMACNA HVAC air duct leakage test manual-2012.
1. Leakage in each type of ductwork shall not exceed:
a. Rectangular ductwork:

Static pressure classification, wg	Leakage class
0.5", 1", 2"	16
3"	8
4", 6", 10"	4

b. Round and flat oval ductwork:

Static pressure classification, wg	Leakage class
0.5", 1", 2"	8
3"	4
4", 6", 10"	2

D. Test pressure shall equal the static pressure classification for the duct. Maximum allowable leakage: maximum leakage shall be 1% of total cfm delivered by the air moving device(s).

E. Submit a report certifying ductwork testing and results.

F. In addition to the tests specified herein, test ductwork located outdoors in accordance with the criteria specified herein for the pressure classification of the ductwork.

G. In addition to the tests specified herein, test supply, outside air and relief ductwork associated with air handling units and exhaust relief ductwork associated with fans, which are part of the smoke control system. Test duct leakage at 1.5 times the maximum fan discharge pressure for positive pressure ductwork and maximum fan suction pressure for negative pressure ductwork. Perform tests before ductwork is insulated. Submit report with leakage results reported in airflow leakage per system within 5 days of test. Leakage shall not exceed 5% of design flow.

H. In addition to the tests specified herein, prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed. In the presence of the code official. Ducts shall be considered to be concealed where installed in shafts or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides. Provide the necessary equipment and perform the grease duct leakage test. A light test or an approved equivalent test method shall be performed to determine that all welded and brazed joints are liquidtight.

I. A light test shall be performed by passing a lamp having a power rating of not less than 100 w through the entire section of duct work to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls. A test shall be performed for the entire duct system, including the hood-to-duct connection. The ductwork shall be permitted to be tested in sections, provided that every joint is tested.

J. Ductwork failing tests shall be reconstructed and retested until satisfactory, before additional ductwork is installed and before ductwork is concealed.

3.16 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

D. Refrigerant piping system testing:

1. Test refrigerant piping, equipment, valves and fittings at a pressure of 250 psig with dry nitrogen or dry carbon dioxide, together with a small amount of refrigerant. Test joints with a soap solution, wipe clean and test again with halide torch or electronic refrigerant leak detector. After leaks have been repaired, evacuate entire system to 500 microns of vacuum for a minimum of 4 hours. Valve off the vacuum pump and observe rise in pressure for 15 minutes. If final pressure is above 750 microns, continue the evacuation and leak repair process until satisfactory results are obtained. After evacuation, charge the system as recommended by the manufacturer.
2. Submit a certificate stating that the dehydration test was performed.

3.17 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
4. Chilled-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.18 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.19 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents, including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans performance forms, including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Heating coil, dry-bulb conditions.
      e. Face and bypass damper settings at coils.
      f. Fan drive settings, including settings and percentage of maximum pitch diameter.
      g. Variable-frequency controller settings for variable-air-volume systems.
      h. Settings for pressure controller(s).
      i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:
    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and speed.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan speed.
    d. Inlet and discharge static pressure in inches wg.
    e. For each filter bank, filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.
    g. Cooling-coil static-pressure differential in inches wg.
    h. Heating-coil static-pressure differential in inches wg.
    i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
    j. Outdoor airflow in cfm.
    k. Return airflow in cfm.
    l. Outdoor-air damper position.
    m. Return-air damper position.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.

e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:

1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
a. System and air-handling-unit identification.

b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

K. Instrument Calibration Reports:

1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.20 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
   2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

C. Seasonal adjustments
   1. Assist the HVAC performance verification supervisor with the seasonal adjustment process. During this effort, the HVAC performance verification supervisor will:
   2. Check the operation, performance, and balance of air and hydronic systems to provide uniform distribution and comfort conditions.
   3. Where deficient operation or defective equipment is discovered, contractor shall provide corrective measures as required by the warranty provisions of these specifications and shall assist the performance verification supervisor in the correction of these deficiencies.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:
   1. Section 23 07 16 "HVAC Equipment Insulation."
   2. Section 23 07 19 "HVAC Piping Insulation."

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Sustainable Design Submittals:
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
   2. Product Data: For adhesives, indicating VOC content.
   3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   4. Product Data: For coatings, indicating VOC content.
   5. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
   6. Product Data: For sealants, indicating VOC content.
   7. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. have successfully completed an apprenticeship program or craft training program.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.04 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.05 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities

having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
3. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

F. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

2.03 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Eagle Bridges - Marathon Industries.
      c. Foster Brand; H. B. Fuller Construction Products.
      d. Mon-Eco Industries, Inc.
   2. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.
2. Verify adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dow Consumer Solutions.
   b. Johns Manville; a Berkshire Hathaway company.
   c. P.I.C. Plastics, Inc.
   d. Proto Corporation.
   e. Sekisui Voltek, LLC.
   f. Speedline Corporation.
2. Verify adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.04 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.
1. VOC Content: 300 g/L or less.
2. Low-Emitting Materials: Verify mastic coatings comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Knauf Insulation.
   d. Vimasco Corporation.
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Interior Use: Suitable for indoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Knauf Insulation.
e. Mon-Eco Industries, Inc.
f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: White.

2.05 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. Verify sealant has a VOC content of 420 g/L or less.
7. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials are compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. Verify sealant has a VOC content of 420 g/L or less.

6. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.06 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect.

D. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Johns Manville; a Berkshire Hathaway company.
b. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Rigid insulation for ductwork installed in mechanical rooms from floor level to 8 ft. AFF. Ductwork installed in mechanical rooms shall be with 8 oz. Canvas lagging, minimum or PVC.

B. Provide continuous insulation on supply duct at joints and throughout duct system from cooling coil to supply air grilles. Insulate all equipment including reheat coils, diffuser necks, fire dampers, and flexible connections.

C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

D. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

F. Install insulation with longitudinal seams at top and bottom of horizontal runs.

G. Install multiple layers of insulation with longitudinal and end seams staggered.

H. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.05 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.06 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.07 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.08 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Surfaces to be insulated shall be clean, dry, and free of foreign material, rust, scale and dirt when insulation is applied. Perform pressure and leakage tests and submit results required by other sections before applying insulation.

B. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

C. Material selections
   1. Where multiple insulation materials are specified herein for the same service, one of the specified materials shall be applied and used consistently throughout the project, subject to the requirements of these specifications.

D. Insulation for duct systems
   1. Insulate the following concealed duct systems with fiberglass blanket insulation, nominal 2.2" thickness, minimum R-value at the installed condition of 6.0 $h \cdot ft^{2} \cdot °f/btu$, with foil-scrim-kraft facing:
   2. Outdoor air duct
   3. Supply duct
   4. Supply diffusers including the neck and back of the housing.
   5. Return ducts in areas that noise may be a problem such as large rectangular ducts within ceiling plenums of occupied areas and exposed rectangular duct in occupied areas.
   6. Return duct in mechanical rooms where the duct may take abuse.
   7. HVAC plenums and unit housings not pre-insulated at factory.

E. Overlap edges 3" and secure 12" on center with copper-clad, stainless steel or galvanized steel wire.

F. Seal joints, breaks, and punctures with tape.

G. On ducts over 24" wide, insulation shall be secured to the underside with mechan-ical fasteners maximum 18" on center each way.

H. Insulation shall be installed with 25% or less compression of the nominal thickness.

I. Insulate the following exposed duct systems with 2" thick rigid fiberglass board, 6 pcf minimum density, with foil-scrim-kraft facing:
   1. Outdoor air duct
   2. Supply duct
   3. Supply diffusers including the neck and back of the housing.
   4. Return ducts in areas that noise may be a problem such as large rectangular ducts within ceiling plenums of occupied areas and exposed rectangular duct in occupied areas.
   5. Return duct in mechanical rooms where the duct may take abuse.
   6. HVAC plenums and unit housings not pre-insulated at factory.

J. Secure with welded pins or clips set in adhesive 18" on center each way with 2 rows per panel minimum.

K. Seal joints and clips with tape.

L. Finish insulation with glass fabric, set in white lagging adhesive.

M. Duct wrap insulation assemblies shall be installed per manufacturer's instructions for the required ratings.

N. Installation
   1. Provide removable and replaceable covers on pumps, equipment, and removable ends of strainers requiring insulation that must be opened periodically for inspection, cleaning, or repair.
   2. Do not use scrap pieces of insulation where a full length section will fit.
   3. Banding wires shall have the twisted terminals turned down toward the insulation without damaging the vapor barrier.
   4. Wire inner layer 9" on center; apply outer layer and finish as specified herein.
   5. Finish open ends of pipe insulation as specified herein for fittings.
   6. Provide rigid inserts at each insulation protector location for piping 1.5" and larger.
   7. Fill hollow steel pipe covering protection saddles with fiberglass insulation.

O. Insulation and vapor barrier shall be continuous around and under standoff brackets used for mounting balancing and control devices on ductwork.

P. Where equipment is furnished with other components and adjoining piping factory-assembled on a skid or other common platform, such equipment and piping shall be insulated as specified herein.

Q. Weatherproofing
   1. Protect insulation, except flexible elastomeric, on piping exposed to weather outside the building with 0.016" thick corrugated aluminum jacketing with factory-applied moisture retarder protective film on the inner surface. Provide 2" overlap at joints with sealant as recommended by the manufacturer. Locate longitudinal joints to shed water. Secure jacketing with aluminum bands every 12" and at end joints.

END OF SECTION

SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:
1. Section 23 07 13 "Duct Insulation."
2. Section 23 07 19 "HVAC Piping Insulation."

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:
1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Data: For sealants, indicating VOC content.
3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.03 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation, and maximum use temperature.

1.05 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule," "Indoor Equipment Insulation Schedule," and "Outdoor, Aboveground Equipment Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.
   1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
      a. Manufacturers: Subject to compliance with requirements, provide products by the following:
         1) Johns Manville; a Berkshire Hathaway company.
   2. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type II for sheet materials.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA.
      b. Armacell LLC.
      c. K-Flex USA.

H. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

I. High-Temperature, Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F.

Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

B. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.060 inch thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.05 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation:
1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant

recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.08 FINISHES

A. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

B. Do not field paint aluminum or stainless steel jackets.

3.09 FIELD QUALITY CONTROL

A. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule" and "Outdoor, Aboveground Equipment Insulation Schedule" articles. For large equipment, remove only a portion adequate to determine compliance.

B. All insulation applications will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.

3.11 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulation for hot equipment
   1. Insulate the following with 3" calcium silicate blocks or 2", 3 pcf minimum density fiberglass board:
      a. Shell and tube heat exchangers.
      b. Inline air separators.
      c. Flash tanks.
      d. Condensate pump receivers.

B. F&T, bucket traps, isolation valves, steam control valves, strainers and PRV’s shall be insulated in accordance with manufacturer instructions with removable, insulation jackets meeting the following requirements: Jackets shall be removable, preformed thermal jackets by Thermaxx or equivalent with a minimum 5-year warranty for materials and labor, silicone jackets, jacket edges sewn with Kevlar thread (not stapled), jacket secured with Velcro or equivalent and/or straps. Specify damp and wet location jackets when required. Provide resilient tags on the jacket exteriors identifying the device and when specified, device ID’s

C. Secure insulation with galvanized bands or on weld pins. Miter or score blocks to ensure tight joints. Seal joints with insulating cement. Apply a thick top coat of insulating cement over entire insulated surface.

D. Insulate the following with removable insulation blankets and pads, 2" thick:
   1. Flanged ends of shell and tube heat exchangers.
   2. Steam pressure reducing valves.
   3. Steam isolation valves, 2.5" and larger.
   4. Steam control valves.

E. Insulation for cold equipment
   1. Insulate chilled water pumps with 1" thick flexible elastomeric sheets. Insulation shall be adhered to inside of 18 gauge aluminum casings. Casings shall be fabricated in a minimum of 2 sections, with flanged and bolted joints or operable latches and hinges. Hardware shall be galvanized or cadmium-plated steel. Casings shall be designed for removal to allow access for maintenance without damaging insulation. Seal penetrations of casings.

2. Insulate chilled water and refrigerant piping appurtenances, thermowells, thermometer test wells, gauge cocks, valve stems, and hangers and supports subject to sweating with flexible elastomeric tape.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes insulation for HVAC piping systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:
   1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
   2. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
   3. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program, certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
   1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.02 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General,"

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Preformed Pipe Sections: sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
   1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
      a. Manufacturers: Subject to compliance with requirements, undefined:
         1) Johns Manville; a Berkshire Hathaway company.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Manson Insulation Inc.
      b. Owens Corning.
   2. Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied ASJ jacket.
   3. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a. Aeroflex USA.
      b. Armacell LLC.
      c. K-Flex USA.

I. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Knauf Insulation.
      c. Manson Insulation Inc.
      d. Owens Corning.
   2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
   3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
   4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.
   2. Semirigid board material with factory-applied ASJ jacket.
   3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.03 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Ramco Insulation, Inc.

2.04 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
1. Adhesive: As recommended by cellular glass manufacturer and with a VOC content of 80 g/L or less.
2. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.
2. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of 80 g/L or less.
3. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Wet Flash Point: Below 0 deg F.
6. Service Temperature Range: 40 to 200 deg F.
7. Color: Black.

D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
2. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. ASJ Adhesive Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
2. Verify adhesives have a VOC content of 50 g/L or less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.

c. Proto Corporation.
d. Sekisui Voltek, LLC.
e. Speedline Corporation.
f. The Dow Chemical Company.

2. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.
3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.05 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.
1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
2. Verify mastics comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.06 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Vimasco Corporation.
2. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of 50 g/L or less.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. Service Temperature Range: 20 to plus 180 deg F.
6. Color: White.

2.07 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. ASJ Flashing Sealants PVC Jacket Flashing Sealants:
1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.
4. Verify sealant has a VOC content of 420 g/L or less.

5. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.08 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2.09 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Airex Manufacturing.
b. Johns Manville; a Berkshire Hathaway company.
c. P.I.C. Plastics, Inc.
d. Proto Corporation.
e. Speedline Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
a. Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 3-mil- thick polysurlyn.
e. Factory-Fabricated Fitting Covers:
1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, undefined:
a. C & F Wire.
b. Johns Manville; a Berkshire Hathaway company.
c. RPR Products, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Continuity: Insulation at hangers, sleeves and penetrations shall be continuous with adjoining insulation.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

E. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
   3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
   4. For below-ambient services, apply vapor-barrier mastic over staples.
   5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
   6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

Q. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.04 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using prefabricated fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with prefabricated fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers. Installation conforms to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When prefabricated insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install pipe insulation, quads, hex sections, or beveled lag segments, adhered together, of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.09 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. General
1. Surfaces to be insulated shall be clean, dry, and free of foreign material, rust, scale and dirt when insulation is applied. Perform pressure and leakage tests and submit results required by other sections before applying insulation.
2. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

B. Material selections
1. Where multiple insulation materials are specified herein for the same service, one of the specified materials shall be applied and used consistently throughout the project, subject to the requirements of these specifications.

C. Insulation for hot pipe
1. Insulate the following pipe with preformed fiberglass pipe insulation of the thickness indicated, and white all service jacket with self-sealing lap except where indicated

	Insulation thickness, inches				
	Pipe Sizes				
	≤ 1"	1"-1.25"	1.5"-3"	4"-6"	≥ 8"
Heating Hot Water	1.5	1.5	2	2	2
Steam, low pressure	2.5	2.5	3	3	3
Condensate	2.5	2.5	2.5	3	3

D. End joint butt strips shall be minimum 3" wide and of material identical to jacket.

E. Secure insulation with 16 gauge nonferrous wire or stainless steel bands 9" on center.

F. Insulate fittings and flanges with preformed or mitered fittings. Wire fittings in place.

G. Provide 0.016" aluminum jacket secured with 0.375" aluminum bands 12" on center.

H. Where temperature maintenance cable is specified herein or indicated on the drawings, piping shall be insulated after application of temperature maintenance cable.

I. Insulation for cold pipe

J. Insulate the following pipe with preformed cellular glass pipe insulation of thickness indicated with a vapor retarder and all service jacket with self-sealing lap:

	Insulation thickness, inches	
	Pipe sizes	
	≤ 1.25"	≥ 1.5"
Chilled water supply and return, except as specified herein	1.5	2
Condensate drain	1	1
Exterior chilled water supply and return	1.5	2
Chilled water supply and return in mechanical rooms ventilated with unconditioned outside air	1.5	2

K. Seal longitudinal and end joints with sealant and mastic. Install insulation with jacket drawn tight with side-laps and end joint butt strips secured. End joint butt strips shall be same material as jacket, not less than 3" wide.

L. Insulate fittings, flanges, strainers, unions, and valves with preformed or mitered cellular glass fitting sections. Secure fittings in place, seal joints and contour mitered sections with insulating cement, and finish with a layer of glass fabric embedded between 2 coats of vapor barrier mastic. Glass fabric shall overlap adjoining insulation at least 2".

M. Where temperature maintenance cable is specified herein or indicated on the drawings, piping shall be insulated after application of temperature maintenance cable.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. PVC, Color-Coded by System: 20 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. Aluminum, Corrugated with Z-Shaped Locking Seam : 0.016 inch thick.

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 SUBMITTALS

A. Refer to Division 01 Section “Submittals” for specific requirements.

B. In addition, provide the following:
1. Certificates of readiness
2. Certificates of completion of installation, prestart, and startup activities.
3. O&M manuals
4. Test reports

C. Control Drawings Submittal
1. The control drawings shall have a key to all abbreviations.
2. The control drawings shall contain graphic schematic depictions of the systems and each component.
3. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Provide a full list of trended and alarm points with alarm thresholds documented.
5. Provide a full points list with at least the following included for each point:
    a. Controlled system
    b. Point abbreviation
    c. Point description
    d. Display unit
    e. Control point or set point (Yes / No)

f. Monitoring point (Yes / No)
g. Intermediate point (Yes / No)
h. Calculated point (Yes / No)

1.5 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.6 COORDINATION

A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded. Submit point to point verification sheets.

C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved. Supply preliminary TAB reports as required

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING, ADJUSTING AND BALANCING VERIFICATION

A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, TAB plan, and certificates to the CxA.

B. Notify the CxA at least ten (10) days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. **Equipment Testing and Acceptance Procedures**: Testing requirements are specified in individual Division 23 sections. Provide submittals, test data, inspector record, and certifications to the CxA.

B. **HVAC&R Instrumentation and Control System Testing:** Assist the CxA with preparation of testing plans.

C. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

1. ***Controls***
2. ***Air Handling Units***
3. ***Exhaust Fans***
4. ***Fan Coil Units***

5. Testing, adjusting, and balancing

3.5 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.6 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.7 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

END OF SECTION 23 08 00

SECTION 23 08 01 - BAS SYSTEM COMMISSIONING

PART 1 - GENERAL

1.01 CONTRACTOR RESPONSIBILITIES

A. Completely install and thoroughly inspect, startup, test, adjust, balance, and document all systems and equipment.

B. Assist Commissioning Authority in verification and performance testing. This will generally include the following:
   1. Attend Commissioning (Cx) progress and coordination meetings, during functional testing, acceptance and punchlist close out. The number of meetings will vary depending on the complexity of the project.
   2. Prepare and submit required draft forms and systems information.
   3. Help establish trend logs of system operation as specified herein.
   4. Demonstrate system operation.
   5. Manipulate systems and equipment to facilitate testing.
   6. Provide instrumentation necessary for verification and performance testing.
   7. Manipulate control systems to facilitate verification and performance testing.
   8. Train Owner's Representatives as specified in Part III of this section.

C. Compensation for Retesting: Contractor shall compensate Owner for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-site time for retesting, will be considered actual damages to the Owner. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 BAS START-UP TESTING, ADJUSTING, CALIBRATION

1. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Startup Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):
   a. Duct air temperature: ±1°F.
   b. Space Temperature: ±2°F
   c. Chilled Water: ±1°F
   d. Hot water temperature: ±2°F.
   e. Duct pressure: ± 0.2" w.g.
   f. Water pressure: ±1 psid
   g. Duct or space Humidity: ±5%
   h. Air flow control: ±5% of setpoint velocity.

B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Substantial Completion and the start of any Commissioning testing.

3.02 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end.

B. Calibration: Calibrate all sensors using the following procedures:
   1. Sensors Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject

to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Section 23 09 01.

3.03 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout at 0, 25, 50 75 and 100% position.

3.04 BAS DEMONSTRATION

A. All BAS Demonstration for the owner shall take place from the BAS graphics prior to the start of commissioning & functional testing.

B. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and Owner. If the Work fails to be demonstrated to conform to the Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority & Owner for re-demonstration, Contractor shall reimburse Owner for costs of subsequent Commissioning Authority site visits.

3.05 BAS WARRANTY PHASE & OPPOSITE SEASON TRENDING AND TESTING:

A. Opposite Season Testing: Within 12 months of completion of the Acceptance Phase, Commissioning Provider/Owner shall schedule and conduct Opposite Season functional performance testing. Contractor shall remedy any contractual deficiencies identified in the opposite season or warranty testing.

3.06 SOFTWARE OPTIMIZATION ASSISTANCE

A. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of 16 hours.

B. The Contractor shall provide the services of a BAS Technician as specified to be at the disposal of the Commissioning Authority/Owner. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the Commissioning Authority/Owner during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days.

C. The BAS Technician provided shall be thoroughly trained in the programming and operation of the controller. If the BAS Technician provided cannot perform every software task requested by the Commissioning Authority/Owner in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority/Owner, to meet the total specified requirement on-site.

3.07 BAS OPERATOR TRAINING AND O&M MANUALS

A. Provide up to 4 complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.

B. Contractor shall submit a Training Plan. On-Site Training: Provide services of controls contractor’s qualified technical personnel for one 8-hour day to instruct Owner's personnel in operation and maintenance of BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training.

END OF SECTION

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Joining materials.
4. Transition fittings.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

B. Sustainable Design Submittals:
1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Environmental Product Declaration: For each product.
4. Health Product Declaration: For each product.
5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.06 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on water quality.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig at 73 deg F.
   3. Makeup-Water Piping: 150 psig at 150 deg F.
   4. Condensate-Drain Piping: 150 deg F.
   5. Blowdown-Drain Piping: 180 deg F.
   6. Air-Vent Piping: 180 deg F.
   7. Safety-Valve-Inlet and Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K.

B. Annealed-Temper Copper Tube: ASTM B88, Type K.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Wrought Copper Unions: ASME B16.22.

2.03 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

2.04 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2-1/2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-water heating piping, aboveground, NPS 3 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2-1/2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Chilled-water piping, aboveground, NPS 3 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Makeup-water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Condensate-Drain Piping, Copper: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

3.02 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.03 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to the following:
1. Section 23 05 23.12 "Ball Valves for HVAC Piping."
2. Section 23 05 23.13 "Butterfly Valves for HVAC Piping."
3. Section 23 05 23.14 "Check Valves for HVAC Piping."
4. Section 23 05 23.15 "Gate Valves for HVAC Piping."

Q. Install unions in piping, NPS 2-1/2 and smaller and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 3 and larger and larger, at final connections of equipment and elsewhere as indicated.

S. Comply with requirements in Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

T. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.04 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tools and procedure, and brazed joints.

J. Pressure-Sealed Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.05 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Use dielectric flange kits.

3.06 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting and coupling.

E. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 05 19 "Meters and Gages for HVAC Piping."

3.08 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.09 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

D. Piping shall not block the swing or use of access doors, panels, servicing of filters or other equipment. Locate unions and shut off valves to allow removal of coil or any module without requiring shut down of any other part of the system.

E. Coils shall be piped for counter-flow configuration.

F. On multiple coils with single control valve provide metering type balancing valve in return from each coil section.

G. The size of pipe runouts to equipment shall be as shown on the equipment schedules, unless noted otherwise on drawings. Pipe runout sizes may or may not be the same as the equipment pipe connection sizes. Provide reducers or expansion fittings where equipment pipe connection sizes differ from pipe runout sizes.

H. Provide reducers before and after control valves to suit size of valve provided. All other valves, strainers, etc. Shall be full line size.

I. Provide a test plug at each temperature and pressure sensor.

J. Cooling coil condensate piping is gravity flow, unless otherwise noted. Provide a cleanout at every change in direction greater than 45 degrees for both pumped and gravity flow condensate piping.

K. Pipe hangers shall support piping independently of equipment.

L. Material of new piping shall match existing at tie-ins.

M. All pipe branches serving coils shall NOT connect to the bottom of horizontal mains. Connecting to the sides or tops of the horizontal mains is acceptable.

N. Pressure gauges: Provide a combination pressure and vacuum gauge at the highest point in the system and show on the riser schematic drawings.

O. Provide a line-sized, bypass around all coil and HX hookups which allows for full flow flushing of the branch piping. Equip with full-port isolation valves.

END OF SECTION

SECTION 23 21 13.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes the following underground hydronic piping:
   1. Ductile Iron pipes and fittings.

1.03 DEFINITIONS

A. Invert: Vertical distance from Project datum reference point to bottom interior pipe surface.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Pipe and tube.
   2. Fittings.
   3. Joining materials.
   4. Transition fittings.
   5. Loose-fill insulation.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.
   1. Include calculations showing requirements for expansion compensation for underground piping.
   2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement at required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
   3. Show pipe sizes, locations, inverts, and pitch. Show piping in trench, piping in conduit, and cased pipe with details showing clearances between piping.
   4. Show insulation thickness.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from hydronic distribution piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31.9, "Building Services Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

C. Further Qualifications
   1. Installer must have performed a minimum of three (3) underground ductile iron pipeline installations for 24" pipe and larger within the last 5 years.
   2. Has been in the underground pipeline utility business and has been performing this type of work for a minimum of 5 years.
   3. Is licensed to perform work in the State of North Carolina.

1.07 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

1.08 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

B. Prior to acceptance of installation and use, contractor shall deliver two (2) copies of survey quality as built construction drawings for UNC to review and approve. Drawing to include GIS survey of points including change of directions, valves & tie in locations. A photograph library of the installation prior to backfilling is required.

C. Photographs should include changes in direction, thrust block installation, pipe restraints and other pertinent information. The photographs must include background landmarks to verify location, orientation and physical attributes of the installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
1. Chilled-Water Piping: 300 psig at 100 deg F.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design underground hydronic piping systems, including restraints and anchors.

2.02 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: ANSI C151/A21.51, centrifugally cast with mechanical-joint bell and plain spigot end with asphalt coating and cement mortar lining conforming to ANSI/AWWA C104/A21.4 Nominal piping wall thickness shall be as follows:

Piping Diameter (in)	Wall Thickness (in)
4 - 8	0.25
10	0.26
12	0.28
14	0.30
16	0.32
18	0.34
20	0.36
24	0.40
30	0.45
36	0.51

B. Fittings shall be ductile iron mechanical joint type manufactured in accordance with ANSI/AWWA C110/A21-10, rated for 250 psi working pressure. Straight pipe joints and fittings are to be restrained joint-type.

C. Piping shall be US Pipe "TR-Flex" or American Cast Iron Pipe "Flex Ring" or approved equal. All joints must be restrained for permanent piping. Pressure rating of 250 psi minimum.

D. All bolts shall be low alloy, high strength steel bolts having minimum yield strength of 45,000 psi and which are cathodic to the pipe, meeting requirements of AWWA C111.

E. Restrained type joint fittings shall be equal to EBBA Iron Series 1100 Megalug restraint systems for mechanical joint ductile iron piping, fittings and valves. Series 1100 solid ring restraints shall have a rated working pressure of 350 psi up to 16" pipe and 250 psi for 18" to 36" pipe. Series 1100 split ring restrains shall have a rated working pressure of 300 psi up to 16" and 200 psi for 18" to 36" pipe. Gasket material shall be SBR.

PART 3 - EXECUTION

3.01 EARTHWORK

A. See Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATION

A. Chilled-Water Piping:
   1. NPS 3 and larger shall be the following:
      a. Schedule ductile-iron pipe; Class 300,

3.03 PIPING INSTALLATION

A. Welding:
   1. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.

B. Where the temperature of the component parts being welded reaches 32°f or lower, the material shall be heated to approximately l00°f for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°f.

C. Welders shall stamp each weld with their personal symbol or code number.

D. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. Reworked welds shall be tested as specified herein.

E. Expansion in the piping shall be accommodated by means of expansion loops and offsets.

F. Provide reducing fittings for changes in pipe sizes.

G. Plastic end covers shall not be removed until field joint is ready to be made.

H. Immediately after installation in the ditch, a partial backfill shall be made in the middle of each length leaving joints exposed for inspection.

I. After hydrostatic test, a backfill of selected earth shall be hand placed and hand tamped in 4" layers to 12" minimum over the top of the jacket. Remainder of the backfill shall be free of rocks over 6" in diameter, frozen earth or foreign matter, and shall be completed in accordance with division 31, earthwork, with the exception that tracked or wheeled vehicles shall not be used for tamping.

J. Unload, install, and test under the supervision of a factory installation supervisor. On completion of the installation, submit a certificate from the manufacturer stating that the installation has been accomplished in accordance with the manufacturer’s recommendations.

K. Provide flanges for disconnecting pipe from valves and as indicated on the drawings.

L. Arrange piping for the venting of air and for drainage of the entire system.

M. Changes in size of vertical piping shall be made with concentric reducers, and in horizontal piping, shall be made with eccentric reducers to maintain uniform top elevation of pipe.

N. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

O. Remove standing water in the bottom of trench.

P. Bed the pipe on a minimum 6-inch layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch clearance between pipes.

Q. Do not backfill piping trench until field quality-control testing has been completed and results approved.

R. Install piping at uniform grade of 0.2 percent. Install required fittings to accommodate capped drains at low points and elsewhere as required for system drainage. Install capped manual air vents at high points.
   1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

S. Install components with pressure rating equal to or greater than system operating pressure.

T. Install piping in straight lines. Do not bend pipe.

U. Install fittings for changes in direction and branch connections. Use long radius elbows with centerline radius of 1.5 diameters.

V. See Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

W. Secure anchors with concrete thrust blocks. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

X. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 23 21 13 "Hydronic Piping."

Y. See Section 23 05 23.13 "Butterfly Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

Z. See Section 23 05 23.15 Gate Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

AA. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

BB. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 03 30 00 "Cast-in-Place Concrete" for concrete and reinforcement.

CC. After field quality-control testing is complete, backfill with 6 inches of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches before using mechanical-compaction equipment.

3.04 JOINT CONSTRUCTION

A. See Section 33 05 00 "Common Work Results for Utilities" for basic piping joint construction.

B. Join pipe and fittings in accordance with the following requirements and Section 23 21 13 "Hydronic Piping":
   1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators, in accordance with "Quality Assurance" Article.

D. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

E. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.05 IDENTIFICATION

A. Install continuous plastic underground warning tapes during backfilling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 31 20 00 "Earth Moving" for warning-tape materials and devices and their installation.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Refer to UNC Guidelines for Pressure Testing
   2. Prepare hydronic piping for testing in accordance with ASME B31.9 and as follows:
      a. Leave joints, including welds, uninsulated and exposed for examination during test.
      b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
      c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
      d. Fill system with water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
      e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid at accessible low points.
   3. Test hydronic piping as follows:
      a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times system design pressure.
      b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
      c. Do not pressurize carrier pipe with air.
      d. Maintain test pressure for four hours with no loss of pressure.

D. Piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.

G. Fill underground piping system with permanent system liquid prior to system testing and balancing.

H. Provide a chilled water monument marker at each change of direction, branch, and 200 feet of straight run of pipe. The marker shall consist of a chilled water marker (provided by Chilled Water). The marker shall be located midway between the two chilled water pipes. Physical location of the markers will be done using as- built drawings supplied by contractor and coordinated with Chilled Water.

I. Install locate wire on top of pipe with an anode bag at the connection to the main piping. The wire shall be taped to the pipe at 10 foot intervals and run full length to the piping. At the building the wire shall be brought to the surface and terminate in a locate wire box. The box shall consist of an electrical handybox with hinged opening and an 18" length of ¾" rigid conduit extended out the bottom of the box. All joints in the locate wire shall be done with Nicotap fittings and shrink wrap.

J. All items, including wire, needed to install the locate wire shall be supplied by UNC. Use extreme caution to keep the wire on top of pipe and not to damage the wire during backfill operations.

K. Install chilled water marking tape 2 feet above each pipe installed.

L. Follow UNC guidelines for water treatment and filling

END OF SECTION

SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Hydronic specialty valves.
2. Air vents.
3. Expansion tanks and fittings.
4. Air/dirt separators and purgers.
5. Strainers.
6. Flexible connectors.

B. Related Requirements:
1. Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 23 05 23.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
3. Section 23 05 23.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
4. Section 23 05 23.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
5. Section 23 05 23.15 "Gate Valves for HVAC Piping" for specification and installation requirements for gate valves common to most piping systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product:
1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.05 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Armstrong Fluid Technology.
b. Bell & Gossett; a Xylem brand.
c. Caleffi North America.
d. Taco Comfort Solutions.

2. Basis of Design: B&G Circuit Setter Plus or Circuit Setter Flo-Setter II
3. Body: Bronze, ball.
4. Ball: Brass or stainless steel.
5. End Connections: Threaded or socket.
6. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.
10. Equipped with differential pressure measurements ports. Flow measurement curves or charts shall be provided with the O&M documentation.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, undefined:
   a. Armstrong Fluid Technology.
   b. Bell & Gossett; a Xylem brand.
2. Basis of Design: B&G Circuit Setter Plus or Circuit Setter Flo-Setter II
3. Body: Cast-iron or steel body, ball, or globe pattern with calibrated orifice or venturi.
4. Ball: Brass or stainless steel.
5. Stem Seals: EPDM O-rings.
6. Disc: Glass- and carbon-filled PTFE.
7. Seat: PTFE.
8. End Connections: Flanged or grooved.
9. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
10. Handle Style: Lever, with memory stop to retain set position.
11. CWP Rating: Minimum 125 psig.
12. Maximum Operating Temperature: 250 deg F.
13. Equipped with differential pressure measurements ports. Flow measurement curves or charts shall be provided with the O&M documentation.

2.02 AIR VENTS

A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bell & Gossett; a Xylem brand.
   b. Caleffi North America.
   c. Taco Comfort Solutions.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bell & Gossett; a Xylem brand.
   b. Caleffi North America.
   c. Taco Comfort Solutions.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

2.03 EXPANSION TANKS AND FITTINGS

A. Diaphragm-Type ASME Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, undefined:
a. Armstrong Fluid Technology.
b. Bell & Gossett; a Xylem brand.
c. Taco Comfort Solutions.
2. Tank: Welded steel, rated for 125 psig working pressure and 280 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.04 AIR/DIRT SEPARATORS AND PURGERS

A. Coalescing-Type Air and Dirt Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Fluid Technology.
b. Bell & Gossett; a Xylem brand.
c. Spirotherm, Inc.
d. Taco Comfort Solutions.
2. Tank: Fabricated steel tank; ASME constructed and stamped for 125 psig working pressure and 270 deg F maximum operating temperature.
3. Coalescing Medium: Stainless steel.
4. Air Vent: Threaded to top of separator.
5. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
6. Blowdown Connection: Threaded to bottom of separator with valve
7. Size: Match system flow capacity.

2.05 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless steel, 20 mesh strainer, or perforated stainless steel basket.
4. CWP Rating: 125 psig.

2.06 FLEXIBLE CONNECTORS

A. Stainless Steel Flexible Connectors:
1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads on all devices for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.02 INSTALLATION OF VALVES

A. Install calibrated-orifice balancing valve at each branch connection to return main.

B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

D. Install pressure-relief and safety-relief valves at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.03 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.
   1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.

C. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install expansion tanks having direct air/water interface above the air separator or air purger. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus tank full of water. Do not overload building components and structural members.
   3. Install piping from air separator or air purger to expansion tank with a 2 percent upward slope toward tank to avoid air entrapment.

F. Install diaphragm- or bladder-type expansion tanks on the floor.

G. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

H. Inline air separators:
   1. Support from the floor on an angle iron frame or prefabricated base.
   2. Support with hangers independently from the adjacent piping.

I. Strainers in water piping shall be installed with blowdown outlets at the low point. Strainers in horizontal steam piping shall be installed on the side.

J. When coils hook-ups utilize combination isolation valves and strainers, provide additional isolation valves where the coil run-out branches from the main.

K. Provide manual vents at high points.

L. The use of automatic air vents is not permitted except at the air / dirt separators.

M. Provide an air vent at the top of all upward flowing risers. Provide an air vent at the end of long horizontal runs. Show these on the riser diagrams.

END OF SECTION

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Separately coupled, in-line centrifugal pumps.

1.03 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of pump.
   1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
   2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design vibration isolation.

2.02 SEPARATELY COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Taco Comfort Solutions.
   3. Bell and Gossett, a Xylem brand.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

D. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet , replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Impeller radius shall not exceed 85% of the pump's cutwater radius. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Type 304 stainless steel Type 316 stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and NBR EPDM FKM bellows and gasket.

E. Shaft Coupling: capable of absorbing vibration.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Enclosure: 1. Motors shall be dripproof, unless otherwise specified herein or indicated on the Drawings .
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Variable-speed motor.
6. Provide integral pump motor variable-speed controller.

2.03 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:
1. Angle pattern.
2. 300-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
4. Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Furnish an extra set of mechanical seals for each pump and submit receipt acknowledging same.

F. Provide base elbow supports for horizontal connections to base-mounted pumps.

G. Pump and motor alignment for each flexible-coupled pump shall be verified to be ±0.002" by the manufacturer after pump and piping have been installed and base has been grouted. Submit a written statement verifying completion and tolerance of alignment.

H. Pump impellers shall be nonoverloading type so motor nameplate rating will not be exceeded at any point on the pump curve up to 125% of the flow indicated on the drawings.

I. Pumps shall be designed for a working pressure of 175 psig and a maximum fluid temperature of 150°f for chilled water service and 240°f for hot water service.

J. Impeller diameter shall not exceed 95% of the maximum impeller diameter available for the pump selection.

K. For chilled water applications: galvanized drain pan, 16 gauge minimum with a 0.5" drain coupling.

3.02 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:
1. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.
1. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

3.03 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.04 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 23 22 13 "Steam and Condensate Heating Piping" and Section 23 22 16 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check, shutoff, and throttling valves on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.
1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

I. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

J. A single pressure gauge with isolation valves to provide suction pressure, discharge pressure, and differential pressure shall be installed on all pumps.

3.05 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.06 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.07 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.08 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Hydronic pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Steel pipe and fittings.
   2. Joining materials.

B. Related Requirements:
   1. Section 23 22 16 "Steam and Condensate Heating Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Steel pipe and fittings.

B. Sustainable Design Submittals:
   1. Product Data: For adhesives and sealants, indicating VOC content.
   2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
   3. Environmental Product Declaration: For each product.
   4. Health Product Declaration: For each product.
   5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Other building services.
   3. Structural members.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Fiberglass Pipe and Fitting Installers: Installers of fiberglass pipe and fittings shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to the following:
   1. ASME Compliance: Comply with ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. HP Steam Piping: 200 psig at 450 deg F.
   2. LP Steam Piping: 15 psig.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.03 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face flanges.
      b. Narrow-Face Type: For raised-face flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel of type to match pipe unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller : Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12 : Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
   1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.02 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2 and Smaller : Schedule 80 , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12 : Schedule 80, Type E, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
   1. Schedule 80, Type S, Grade B, steel pipe; Class 150 cast-iron fittings; and threaded joints.

3.03 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow. Under no exceptions will the pipe be installed with dips or back-sloping with one exception: steam pipe serving control valves shall slope back to the drip or main.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to the following Sections or other Sections as needed:
   1. Section 23 05 23.12 "Ball Valves for HVAC Piping."
   2. Section 23 05 23.13 "Butterfly Valves for HVAC Piping."
   3. Section 23 05 23.14 "Check Valves for HVAC Piping."
   4. Section 23 05 23.15 "Gate Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

U. Comply with requirements in Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 05 18 "Escutcheons for HVAC Piping."

3.04 INSTALLATION OF STEAM AND CONDENSATE PIPING SPECIALTIES

A. Comply with requirements in Section 23 22 16 "Steam and Condensate Heating Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.05 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers, supports, and anchor devices.

C. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping and steel steam condensate piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within 12 inches of each fitting.

G. Support vertical runs of steel steam supply piping and steel steam condensate piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.06 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.08 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Testing Agency: a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 22 16 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Strainers.
2. Flash tanks.
3. Stop-check valves.
4. Steam safety valves.
5. Pressure-reducing valves.
6. Steam traps.
7. Condensate meters.

B. Related Requirements:
1. Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 23 05 23.11 "Globe Valves for HVAC Piping" for specification and installation requirements for globe valves common to most piping systems.
3. Section 23 05 23.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
4. Section 23 05 23.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
5. Section 23 05 23.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
6. Section 23 05 23.15 "Gate Valves for HVAC Piping" for specification and installation requirements for gate valves common to most piping systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Strainer.
2. Flash tank.
3. Valve.
4. Steam trap.
5. Air vent and vacuum breaker.
6. Connector.
7. Meter.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to the following:
1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Components and installation shall be 250 class piping

2.02 STRAINERS

A. Y-Pattern Strainers, Cast Iron:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Keckley Company.
b. Metraflex Company (The).
c. Mueller Steam Specialty; A WATTS Brand.
d. Titan Flow Control, Inc.
2. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
4. Strainer Screen: Stainless steel, 20 -mesh strainer or perforated stainless-steel basket.
5. Tapped blowoff plug.
6. Rating: 250-psig working steam pressure.

2.03 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code for 150-psig rating, and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.04 STOP-CHECK VALVES

A. Stop-Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. A.Y. McDonald Mfg. Co.
b. Crane; a Crane Co. brand.
c. Jenkins Valves.
d. Lunkenheimer Valves.
2. Body and Bonnet: Malleable iron.
3. End Connections: Flanged.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
7. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

2.05 STEAM SAFETY VALVES

A. Steam Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Armstrong International, Inc.
c. Spirax Sarco Limited.
d. WATTS.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
5. Pressure Class: 250.
6. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Steam Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Armstrong International, Inc.

c. Kunkle Valve.
d. Spirax Sarco Limited.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.06 PRESSURE-REDUCING VALVES

A. Pressure-reducing valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco Limited.
   d. Spence
2. Basis of Design: Spence Type-E with type D pilot
3. ASME labeled.
4. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
5. Description: Pilot-actuated diaphragm type, with adjustable pressure range and positive shutoff.
6. Body: Cast iron.
7. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
8. Trim: Hardened stainless steel.
9. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
10. Gaskets: Non-asbestos materials.

2.07 STEAM TRAPS

A. Float and Thermostatic Steam Traps, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Spirax Sarco Limited.
2. Body and Bolted Cap: ASTM A126 cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Steam Traps, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Barnes and Jones

c. Spirax Sarco Limited.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless steel inlet strainer within the trap body.
8. Air Vent: Stainless steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.08 CONDENSATE METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. NIAGARA meters, WPX or MTX

B. Body: Cast iron, bronze, or brass.

C. Turbine: Copper, brass, or stainless steel.

D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.

E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
4. Microprocessor Enclosure: NEMA 250, Type 4.

F. Pressure Rating: Atmospheric.

G. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Strainers: Strainers in horizontal steam piping shall be installed pointing to the 3:30 position (slightly down from horizontal). Strainers in condensate piping shall be pointed down (6:00 position).

D. Vacuum breakers: Vacuum breakers are required on the steam inlet side of coils and heat exchangers. Vacuum breakers are also required on the outlet side of modulated coils and converters. Install vacuum breakers on a 15" cooling stems. Pre-approved models: Hoffman model 62, Barnes and Jones VB 3875. Construction: brass body, stainless steel spring and valve, silicon O-ring. WP 125 psig, WT 350 °F. Typically set pressure: 2" vacuum.

3.02 INSTALLATION OF PIPING

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full-port ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Section 23 05 23.11 "Globe Valves for HVAC Piping," Section 23 05 23.12 "Ball Valves for HVAC Piping," Section 23 05 23.13 "Butterfly Valves for

HVAC Piping," Section 23 05 23.14 "Check Valves for HVAC Piping," and Section 23 05 23.15 "Gate Valves for HVAC Piping."

D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment and elsewhere as indicated.

E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full-port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Flash Tank:
1. Pitch condensate piping down toward flash tank.
2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
3. Install thermostatic air vent at tank top.
4. Install safety valve at tank top.
5. Install full-port ball valve, and swing check valve on condensate outlet.
6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for 3 times the calculated heat load.
7. Install pressure gage on low-pressure steam outlet according to Section 23 05 19 "Meters and Gages for HVAC Piping."

3.03 INSTALLATION OF STEAM TRAPS

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.04 INSTALLATION OF PRESSURE-REDUCING VALVES

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Section 23 05 19 "Gages for HVAC Piping."

F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.05 INSTALLATION OF STEAM OR CONDENSATE METERS

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.

B. Provide data acquisition wiring. See Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

3.06 INSTALLATION OF SAFETY VALVES

A. Install safety valves according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION

SECTION 23 22 23 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes packaged, factory-assembled, boiler feedwater pumps.

1.03 DEFINITIONS

A. NPSHR: Net-positive suction head required.

1.04 ACTION SUBMITTALS

A. Product Data: For each unit to include the following:
   1. Equipment performance and operating characteristics, such as rated makeup water, feedwater, steam condensate, and steam flow rates; working pressure; tank capacities; temperature and NPSHR; and pump performance curves with selection points clearly indicated.
   2. Furnished specialties and accessories.
   3. Construction details, material descriptions, dimensions and weight of individual components, and profiles and finishes.
   4. Force and moment capacity of each field piping connection.
   5. Dimensioned location of low, high, and normal water level showing operating set point and each alarm set point.
   6. Temperature and pressure rating, size, and materials of construction for trim components including piping, fittings, flanges, unions, and valves. Provide valve manufacturer Product Data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
   7. Manufacturer Product Data showing size, scale range, and accuracy of thermometers and pressure gages.
   8. Detailed information of controls including Product Data with technical performance, operating characteristics, and sequence of operation.
   9. Product Data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
   4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to scale, indicating equipment manufacturer's service clearances, structure and base attachment, piping, power, and controls. Each view to show screened background with the following:
   1. Column grids, beams, columns, and concrete equipment bases.
   2. Room layout with walls, floors, and roofs, including each room name and number.
   3. Equipment and products located in vicinity of boiler feedwater pumps and part of final installation including products of other trades, such as lighting, fire suppression systems, and plumbing systems.

B. Source quality-control reports.

C. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For feedwater equipment to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Gaskets: Furnish one replacement gasket(s) for each gasketed opening.
   2. Gage Glass: Furnish one replacement glass(es) for each gage glass.
   3. Pump Mechanical Seal Set: Furnish one replacement mechanical seal set(s) for each unique pump mechanical seal.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipping:
   1. Clean flanges and exposed-metal surfaces and treat with anticorrosion compound after assembly and testing.
   2. Protect flanges, pipe openings, and nozzles with flange covers or with screwed-in plugs.
   3. Ship boiler feedwater pumps from the factory free of water. Drain water and blow pumps dry with compressed air if required to remove all water before shipping.
   4. Cover and protect electrical and control devices and open connections.

B. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

C. Comply with manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. ASME Compliance:
   1. Fabricate and label unit receivers of boiler feedwater pumps according to ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
   2. Factory-installed piping that connects pumps to receivers shall comply with ASME B31.9, "Building Services Piping."
   3. Safety valves and pressure vessels shall bear the appropriate ASME label.

B. Operation Following Loss of Normal Power:
   1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply shall automatically return equipment and associated controls to the state in which equipment was operating immediately before loss of normal power. This shall be accomplished without need for manual intervention by an operator when normal power is restored.
   2. Provide means and methods required to satisfy requirement even if not explicitly indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 FEEDWATER UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aurora Pump.
   2. Lockwood Products, Inc.
   3. MEPCO (Marshall Engineered Products Co.).
   4. Shippensburg Pump Co., Inc.
   5. Skidmore Pump.

B. Description: Factory-assembled and -tested unit consisting of a receiver, feedwater pumps, controls, and the following features and accessories:
   1. Bimetal dial-type thermometer graduated in Fahrenheit .
   2. Level gage glass with stops at top and bottom.
   3. Lifting eyes.
   4. Companion flanges.
   5. Pump, suction and discharge isolation valve, inlet strainer, discharge check valve, and liquid-filled pressure gage.
   6. Makeup Water Assembly: Electric level controller and valve; with inlet strainer and three-valve bypass.
   7. Feedwater Heater: Sparge tube, thermostat, and control valve.
   8. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106/A 106M, Type S, Grade B, Schedule 40 ; with threaded joints and fittings.
      a. Cast-Iron Threaded Fittings: ASME B16.4; Class 300 .
      b. Malleable-Iron Threaded Fittings: ASME B16.3, Class 300.
      c. Forged-Steel Fittings: ASME B16.11, Class 3000.
      d. Malleable-Iron Unions: ASME B16.39; Class 300.
      e. Forged-Steel Unions: MSS SP-83, Class 3000.
   9. Factory-Installed Pipe, NPS 3 and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106/A 106M, Type S, Grade B, Schedule 40 ; with welded joints and carbon-steel fittings and flanges.
      a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
      b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 300, including bolts, nuts, and gaskets.
   10. Pump-discharge bypass with relief valve or orifice plate sized to provide continuous pump operation with boiler feedwater valve closed.
   11. Threaded connection and provision for chemical injection quill.
   12. Sample cooler.

C. Receiver:
   1. Material: Close-grain cast iron .
   2. Finish: Primer .
   3. Factory-Applied Insulation and Jacket: Minimum thickness of 2 inches for mineral-fiber pipe and tank insulation. Cover insulation with stucco-embossed aluminum jacket.
   4. Mounting Arrangement: Floor mounted.
   5. Mounting Frame: Structural-steel stand to support receiver and pumps.
   6. Drain connection with valve.

D. Vertical Feedwater Pump: Flange-mounted, close-coupled, 2-stage, centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 212 deg F ; with the following features:
   1. Impeller: Bronze .
   2. Seals: Mechanical.
   3. Motor: Totally enclosed enclosure. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

E. Control panel shall be unit mounted and factory wired and shall include the following:
   1. NEMA 250, Type 4 enclosure.
   2. Single-point field power interface to fused disconnect. Withstanding rating of disconnecting means shall protect equipment. Coordinate requirements with field electrical power source.
   3. NEMA-rated motor controller for each motor, and include a hand-off-auto switch and overcurrent protection.
      a. Alternating controls for multiple-pump units with intermittent operation as indicated by control sequence.
   4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   5. Wiring outside of an enclosure in a metal raceway. Make connections to motor with liquidtight conduit.

6. Removable control mounting plate.
7. Visual indication of status and alarm with momentary test push button.
8. Audible alarm and silence switch.
9. Visual indication of elapsed run time, graduated in hours.
10. Fused control-circuit transformer.
11. Microprocessor-based controller.

F. Receiver Makeup Water Control Sequence:
1. Mechanical float operates integral valve to maintain water-level set point.
2. Visual and audible alarm indication of low and high receiver-water level.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test performance and submit test results on packaged boiler feedwater pump units, according to ASME PTC 12.1, before shipping to Project.

B. Witness Testing:
1. Allow Owner access to witness source quality-control testing.
2. Notify Architect and Owner 15 days in advance of testing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting feedwater unit performance, maintenance, and operations.
1. Boiler feedwater pump unit locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, control, and electrical connections.

B. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping to verify actual locations of piping connections before installation of boiler feedwater pumps.

C. Examine areas for suitable conditions where boiler feedwater pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:
1. Install feedwater unit on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

C. Install unit to permit access for maintenance.

D. Support piping independent of equipment.

E. Install parts and accessories shipped loose.

F. Install control and electrical devices furnished with units that are not factory mounted.

G. Install control and power wiring to field-mounted control and electrical devices furnished with units that are not factory installed.

H. Protect units from corrosion.
1. Before filling with water, protect by dry storage method recommended by manufacturer.
2. After filled with water, protect by wet storage method recommended by manufacturer.

3.03 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 23 22 13 "Steam and Condensate Heating Piping" and Section 23 22 16 "Steam and Condensate Heating Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to boiler feedwater pumps, allow space for service and maintenance.

C. Connect makeup water piping and cooling-water piping with reduced-pressure backflow preventers.

D. Install overflow drain piping to nearest floor drain.

E. Install piping from unit drain connections and extend to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation if required.

F. Install vents and extend to outdoors; terminate with elbow turned down and an insect screen.

G. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

1. Provide a temperature-controlled, non-potable, domestic cold water source to cool hot equipment drains to deliver a discharge temperature of 140 deg F .

H. Connect chemical treatment piping to each boiler feedwater pump unit chemical treatment connection with check valve and isolation valve.

3.04 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.05 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between boiler feedwater pump units and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between boiler feedwater pump unit control interface and control system to provide remote monitoring.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Boiler feedwater pump will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.07 ADJUSTING

A. Adjust boiler water-level controls to properly stage unit.

B. Set field-adjustable controls.

3.08 CLEANING

A. Clean equipment internally; remove coatings applied for protection during shipping and storage, foreign material, and oily residue according to manufacturer's written instructions. Following cleaning procedures, unit shall be washed and flushed until water leaving unit is clear.

B. Clean strainers.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boiler feedwater units.

B. Video training sessions, and provide electronic copy of video to Owner.

END OF SECTION

SECTION 23 25 13 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:
   1. Manual Automatic chemical-feed equipment.
   2. Chemicals.

1.03 DEFINITIONS

A. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

B. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.04 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Bypass feeders.
   2. Chemical-treatment test equipment.
   3. Chemical material safety data sheets.

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

D. Water Analysis: Illustrate water quality available at Project site.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize

corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Provide hot water treatment consistent with UNC standard treatment procedures.

2.02 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal.
2. Minimum Working Pressure: 125 psig

2.03 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, corrosion inhibitors, alkalinity, hardness, and other properties recommended by manufacturer.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
1. Two station rack for closed-loop systems.

2.04 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.01 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.02 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.

B. Install seismic restraints for equipment and floor-mounting accessories, and anchor to building structure. Comply with requirements in Section 23 05 48 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water-testing equipment on wall near water-chemical-application equipment.

D. Install interconnecting control wiring for chemical-treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equip with the following:
1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
2. Install water meter in makeup-water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.

5. Install a swing check on the inlet after the isolation valve.

3.03 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 23 21 13 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 23 05 23.11 "Globe Valves for HVAC Piping," Section 23 05 23.12 "Ball Valves for HVAC Piping," Section 23 05 23.13 "Butterfly Valves for HVAC Piping," and Section 23 05 23.15 "Gate Valves for HVAC Piping."

E. Comply with requirements in Section 22 11 19 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.05 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Final Acceptance and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.

5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.06 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION

SECTION 23 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.03 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.04 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VFCs.
   2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.
   1. Certificate of compliance.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.09 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
2. Danfoss Inc.
3. Schneider Electric USA, Inc.

2.02 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

B. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
1. Comply with NEMA ICS 7, NEMA ICS 61800-2,

C. Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range ; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
   7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
   8. Humidity Rating: Less than 95 percent (noncondensing).
   9. Altitude Rating: Not exceeding 3300 feet.
   10. Vibration Withstand: Comply with NEMA ICS 61800-2.
   11. Overload Capability: 1.1times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   13. Speed Regulation: Plus or minus 5percent.
   14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

I. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.

J. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Loss-of-phase protection.
   9. Reverse-phase protection.

10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

L. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC NO alarm contact that operates only when circuit breaker has tripped.

2.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

2.04 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
   1. Hardwired Points:
      a. Monitoring: On-off status
      b. Control: On-off operation,
   2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.05 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.06 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   1. Bypass Contactor: Load-break, NEMA-rated contactor.
   2. Input and Output Isolating Contactors: Non-load-break, NEMA rated contactors.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF/AUTO selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices. Provide BACNET Integration Card as required for controls operation.
   6. Overload Relays: NEMA ICS 2.
      a. Solid-State Overload Relays:
         1) Switch or dial selectable for motor-running overload protection.
         2) Sensors in each phase.
         3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
         4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

5) Analog communication module.

b. External overload, reset push button.

2.07 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

2.08 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Other Wet or Damp Indoor Locations: Type 4.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.09 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

1. Harmonic Distortion Control:
   a. The variable frequency drive manufacturer shall perform a harmonic analysis study in accordance with IEEE 399-1997. The study shall establish the requirements for harmonic distortion control. Harmonic analysis study report shall be submitted

concurrently with the variable frequency drive submittals and shall include variable frequency drives factory-installed on equipment, such as chillers.

b. Variable frequency drive design shall be such that the maximum contribution from all variable frequency drives does not exceed the following:
   1) IEEE 519-2014 voltage and current distortion limits at the point of common coupling.
   2) 5% total demand distortion (total harmonic current distortion in percent of maximum demand load current) and 3% total harmonic voltage distortion at each the building service distribution transformer secondary switchgear switchboard motor control center panelboard engine-generator set output terminals input terminals of variable frequency drives.
   3) Variable frequency drives shall limit the harmonic distortion imposed on the building electrical system to voltage and current distortion limits as defined above by utilizing DC link chokes and/or integral 3-phase AC input line reactors with minimum impedance of 3%. Variable frequency drives 75 100 hp and above shall utilize an 18-pulse multiple bridge rectifier converter with integral phase-shifting auto-transformer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch VFC.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Comply with NECA 1.

3.03 CONTROL WIRING INSTALLATION

A. Bundle, train, and support wiring in enclosures.

B. Connect selector switches and other automatic-control devices where applicable.
1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.04 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Acceptance Testing Preparation:
1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:
1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
   a. Initial Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Final Acceptance.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Acceptance.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Final Acceptance.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Double wall round and flat-oval ducts fittings.
4. Sheet metal materials.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:
1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Sealants and gaskets.

B. Sustainable Design Submittals:
1. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Product Data: For sealants, indicating VOC content.
5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
6. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

D. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
   2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
   3. Where specified for specific applications, all joints shall be welded.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
   1. Where specified for specific applications, all joints shall be welded.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Elgen Manufacturing.
      b. GSI; a DMI Company.
      c. Linx Industries (formerly Lindab).
      d. McGill AirFlow LLC.
      e. MKT Metal Manufacturing.
      f. Nordfab Ducting.
      g. SEMCO, LLC; part of FlaktGroup.
      h. Set Duct Manufacturing.
      i. Sheet Metal Connectors, Inc.
      j. Spiral Manufacturing Co., Inc.
      k. Stamped Fittings Inc.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
   1. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
      a. Construct ducts of galvanized sheet steel unless otherwise indicated.
   2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Transverse Joints in Ducts Larger Than 60Inches in Diameter: Flanged.
   3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials

involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Inner Duct: Minimum 24-gauge perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent solid galvanized sheet steel.

C. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg Fat 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

D. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534/C 534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. at 75 deg F mean temperature.

2.05 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.06 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.

5. Use: O.
6. Verify sealant has a VOC content of 420 g/L or less.
7. Verify sealant complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.07 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.
   1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
   2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

O. Pressure relief doors

P. Install vertically with the latch mechanism at the top.

Q. Flexible ductwork

R. Seal joints as recommended by manufacturer. Maximum length of flexible ducts to diffusers shall be 7'. Use round galvanized duct, same size as flexible duct, for longer runouts.

S. Flexible ductwork shall be fastened to spin-in fittings, collars and transitions by draw bands and duct tape.

T. For diffusers, size same diameter as diffuser neck to which it connects.

U. Where size of flexible duct is different than size of collar, make connection with a sheet metal transition.

V. Sheet metal work - general
   1. Changes in shape, dimension, or direction shall be made with a maximum transition, offset, or combination thereof of 1 to 7.

W. Except where indicated otherwise on the drawings, use metal hat sections or standoff brackets in lined ductwork to install dampers, turning vanes or coils. Hat sections or standoff brackets shall be the same height as the lining thickness.

X. Openings in plenum casings for access doors shall be 9" above the floor. Hinge doors to close with plenum pressure.

Y. Separate galvanized sheet metal from aluminum or copper with lead or felt gaskets.

Z. Provide supplemental stiffening and supports to ducts and apparatus casings to prevent drumming, sagging and to provide a structurally sound assembly.

AA. Entire air system installation shall be rigid, and free from rattles and air noises. Interior of ducts shall be smooth.

BB. Provide angle brackets inside ductwork on both sides to support slip-in electric heating coils in vertical ducts over 24" wide.

CC. Provide transitions between different size sections of air handling units.

DD. Install uninsulated ductwork exposed in finished areas against the ceiling.

EE. Install insulated ductwork with a minimum clearance of 18" to grease hoods.

FF. Provide offsets, elbows, and transitions to coordinate with other work.

GG. Provide transitions to connect ductwork to equipment and coils.

HH. Elbows:
   1. Elbows in round and flat oval ductwork are specified hereinbefore.
   2. Radius elbows in rectangular and square ductwork shall have an inside radius equal to the width of the duct, except where space conditions prohibit, in which case a reduced inside radius with full heel radius is permitted. Where the space conditions require the inside radius to be less than 75% of the duct width, provide multiple splitter vanes inside the elbow.
   3. Square (mitered) elbows in rectangular and square ductwork shall contain single-thickness turning vanes and shall be limited to 90° turn applications.

II. Vanes shall be parallel to airflow.

JJ. Vanes exceeding the maximum unsupported length defined by SMACNA shall be divided into multiple sections with intermediate vane rails or shall be braced with tie rods spanning perpendicularly across the leading edges of the vanes. The tie rods shall be welded to the leading edge of each vane.

KK. Turns less than 90° in rectangular and square ductwork shall be made with radius type elbows. Mitered elbows are not permitted.

LL. Reused grilles, registers, diffusers, multivaned deflectors, louvers, screens and dampers shall be in first class condition or new shall be installed.

MM. Seal wall and floor penetrations.

NN. Internal surfaces of clothes dryer exhaust shall be free of obstructions. Sheet metal screws shall not be used for fastening. Elbows in square and rectangular ductwork shall be radius type without splitter vanes.

OO. Instrument test ports: provide where required for measurements.

PP. Air distribution systems
1. New ductwork and air distribution equipment in systems shall be thoroughly cleaned internally of dust, dirt and debris before installation of filters and operation of systems. Submit signed statement certifying completion of cleaning before installation of filters.
2. Provide a written construction indoor air quality (iaq) management plan for use during demolition and construction. Maintain a detailed digital photograph log of the iaq plan practices followed during construction.

QQ. Exhaust ductwork from washing appliances
1. Horizontal washing tank dishwasher pot washer ductwork shall have sides and bottom made from single sheets of metal. Seal upper longitudinal and transverse joints, and weld bottom and side transverse joints.
2. Vertical washing tank dishwasher pot washer ductwork shall have welded transverse and longitudinal joints.
3. Vertical and horizontal rack washer, cage washer, and tunnel washer ductwork shall have welded transverse and longitudinal joints.
4. Install duct from washing tank, dishwasher, rack washer, and pot washer grading down to the tank, washer, without traps or dips.
5. Install duct from cage washer, and tunnel washer grading down to the washer, exhaust grille, without traps or dips.

RR. Sound attenuators
1. Assemble attenuators to form a rigid bank and fit leading edges with a continuous metal nosing. Blank-off and seal around perimeter of sound attenuator bank.

SS. Round and flat oval ductwork
1. Exposed ductwork shall be parallel to building surfaces and structural members, and shall have seams aligned at joints.
2. Joints shall be sealed with duct sealer. Duct sealer shall not be visible on the exterior of the ductwork. Sheet metal screws shall not be used for joints in .
3. Access panels and access doors
   a. Provide access panels of sufficient size and quantity for access to fire dampers, smoke dampers, controls, air measuring stations, coils, duct smoke detectors, humidifiers, and where ductwork covers electrical boxes. Install in appropriate locations to allow cleaning, oiling, inspection, repair and maintenance.
   b. Open each to verify that swing space is clear and access into duct or plenum is unobstructed.

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Outdoor, Return-Air Ducts: Seal Class A.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class A.
8. Unconditioned Space, Return-Air Ducts: Seal Class A.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Adjust hangers and supports so that loading is uniform.

G. Support horizontal ductwork not more than 8' on center. Ductwork shall be directly suspended from or supported by the building structure.

H. Support ductwork associated with smoke control system directly from fire resistant rated structural elements of the building.

I. Support sound attenuators independently of the ductwork.

J. Flat oval ductwork shall be reinforced and supported with trapeze hangers.

K. Where ducts are suspended below ceilings, extend hangers through the ceiling and secure to the structure as specified herein.

L. Support vertical ducts at each floor with a minimum of 2 supports attached to the duct and fastened to the floor or structure.

M. Provide for side takeoffs from rectangular ductwork to terminal units.
1. Install 45° takeoff fittings to correspond with direction of airflow.
2. Install concentric takeoff fittings where terminal units are connected to the supply duct loop.

N. CONNECTIONS

O. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

P. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.05 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
b. Supply Ducts with a Pressure Class of 4- Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
c. Return Ducts with a Pressure Class of 4- Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
d. Exhaust Ducts with a Pressure Class of 4- Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
e. Outdoor-Air Ducts ~~with a Pressure Class of 4- Inch wg or Higher~~: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice for testing.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.07 STARTUP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.08 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:
1. Ducts Connected to Fan Coil Unitsand Terminal Units :
a. Pressure Class: Positive 2- inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.
2. Ducts Connected to Constant-Volume Air-Handling Units :
a. Pressure Class: Positive 3- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 2.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units :
a. Pressure Class: Positive 4- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 2.
4. Ducts Connected to Equipment Not Listed Above:
a. Pressure Class: Positive 4- inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:
1. Ducts Connected to Fan Coil Unitsand Terminal Units :
a. Pressure Class: Positive or negative 2- inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.
2. Ducts Connected to Air-Handling Units :
a. Pressure Class: Positive or negative 2- inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.
3. Ducts Connected to Equipment Not Listed above:
a. Pressure Class: Positive or negative 2- inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.

d. SMACNA Leakage Class for Round and Flat Oval: 4.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
a. Pressure Class: Negative 2- inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.
2. Ducts Connected to Air-Handling Units :
a. Pressure Class: Positive or negative 2- inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.
3. Ducts Connected to Equipment Not Listed above:
a. Pressure Class: Positive or negative 6- inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure; A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units :
a. Pressure Class: Positive or negative 2- inch wg.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

F. Double-Wall Duct Interstitial Insulation:
1. Supply-Air Ducts: 2 inches thick.
2. Return-Air Ducts: 2 inches thick.

G. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Velocity 1000 fpm or Lower:
1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.
b. Velocity 1000 to 1500 fpm:
1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
c. Velocity 1500 fpm or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
   1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
   2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
   3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
   4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Combination fire and smoke dampers.
7. Flange connectors.
8. Duct silencers.
9. Turning vanes.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Duct accessory hardware.

B. Related Requirements:
1. Section 23 33 46 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 28 46 21.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.
3. Section 28 46 21.13 "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Sustainable Design Submittals:
1. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Pottorff.
   3. Ruskin Company.

B. Description: Gravity balanced.

C. Performance:
   1. Maximum Air Velocity: 1000 fpm.
   2. Maximum System Pressure: 1 inch wg.
   3. AMCA Certification: Test and rate in accordance with AMCA 511.
   4. Leakage:
      a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.

D. Construction:
   1. Frame:
      a. Hat shaped.
      b. 16-gauge- thick, galvanized sheet steel, with welded or mechanically attached corners.
   2. Blades:
      a. Multiple single-piece blades.
      b. Center pivoted, maximum 6-inch width, 16-gauge- thick, galvanized sheet steel with sealed edges.
   3. Blade Action: Parallel.

E. Blade Seals: Neoprene, mechanically locked.

F. Blade Axles:
   1. Material: Galvanized steel.
   2. Diameter: 0.20 inch.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

I. Bearings: Steel ball.

J. Damper Actuator - Electric:
   1. Electric - Refer to controls specification section for more information.
   2. UL 873 plenum rated.

3. Two position with fail-safe spring return.
   a. Sufficient motor torque and spring torque to drive damper fully closed with adequate force to achieve required damper seal.
   b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.
6. Environmental Enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 23 80 00 BAS.
2. Electrical Connection: 24 V, 60 Hz.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
2. Screen Mounting:
   a. Mounted in sleeve.
      1) Sleeve Thickness: 20 gauge minimum.
      2) Sleeve Length: 6 inches minimum.
3. Screen Material: Aluminum.
4. Screen Type:

2.03 MANUAL VOLUME DAMPERS

A. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Greenheck Fan Corporation.
   b. Pottorff.
   c. Ruskin Company.
2. Performance:
   a. AMCA Certification: Test and rate in accordance with AMCA 511.
   b. Leakage:
      1) Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
   a. Linkage: Out of airstream.
   b. Suitable for horizontal or vertical airflow applications.
4. Frames:
   a. Hat, U, or angle shaped.
   b. Thickness: 16-gauge galvanized sheet steel.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel; 16 gauge thick.
6. Blade Edging Seals:
   a. Closed-cell neoprene.
   b. Inflatable seal blade edging or replaceable rubber seals.
7. Blade Jamb Seals: Neoprene.
8. Blade Axles: Galvanized steel.
9. Bearings:
   a. Molded synthetic.

b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

10. Tie Bars and Brackets: Galvanized steel.
11. Locking device to hold damper blades in a fixed position without vibration.

B. Jackshaft:
1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.04 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.

B. General Requirements:
1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:
1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:
1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
a. Hat, U, or angle shaped.
b. 0.08-inch- thick extruded aluminum.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
a. Multiple blade with maximum blade width of 8 inches.
b. Opposed-blade design.
c. Aluminum.
d. 14-gauge- thick air foil dual skin.
5. Blade Edging Seals:
a. Replaceable Closed-cell neoprene.

6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
    a. Molded synthetic.
    b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

E. Damper Actuator - Electric:
1. Electric - Refer to controls specification section for more information.
2. UL 873, plenum rated.
3. Fully modulating with fail-safe spring return.
    a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
    b. Minimum 90-degree drive rotation.
4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:
    a. Temperature: Minus 40 to plus 130 deg F.
    b. Humidity: 5 to 95 percent relative humidity noncondensing.
6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

F. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 23 80 00 BAS.
2. Electrical Connection: 24 V, 60 Hz.

2.05 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Greenheck Fan Corporation.
3. Pottorff.
4. Ruskin Company.

B. Type: dynamic; rated and labeled in accordance with UL 555 by an NRTL.

C. Closing rating in ducts up to 6-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream ; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed galvanized sheet steel, interlocking. Material gauge is to be in accordance with UL listing.

I. Horizontal Dampers: Include blade lock and stainless steel closure spring.

J. Heat-Responsive Device:
1. Replaceable, 165 deg F rated, fusible links.
2. Replaceable link and switch package, factory installed, 165 deg F rated.

2.06 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Greenheck Fan Corporation.

3. Pottorff.
4. Ruskin Company.

B. General Requirements:
1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.
4. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.
5. Factory install damper actuator by damper manufacturer as integral part of damper assembly. Coordinate actuator location, mounting, and electrical requirements with damper manufacturer.

C. Performance:
1. AMCA Certification: Test and rate in accordance with AMCA Publication 511.
2. Leakage:
   a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:
1. Suitable for horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
   a. Hat shaped.
   b. Galvanized sheet steel, with welded corners and mounting flange.
   c. Gauge in accordance with UL listing.
4. Blades:
   a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
   b. Maximum width and gauge in accordance with UL listing.
5. Blade Edging Seals:
   a. Silicone rubber.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel ; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage is to be mounted out of airstream.
8. Bearings:
   a. Molded synthetic.

E. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking; gauge in accordance with UL listing.

F. Damper Actuator - Electric:
1. Electric - Refer to controls specification section for more information.
2. UL 873, plenum rated.
3. Designed to operate in smoke-control systems complying with UL 555S requirements.
4. Two position with fail-safe spring return.
   a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
   b. Maximum 15-second full-stroke closure.
   c. Minimum 90-degree drive rotation.
5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.

b. Humidity: 5 to 95 percent relative humidity noncondensing.
7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with single-point wiring connection.

G. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 23 80 00 BAS
2. Electrical Connection: 120 V, 60 Hz.

H. Accessories:
1. Auxiliary switches for signaling fan control or position indication.
2. Momentary test switch Test and reset switches, remote mounted.
3. Smoke Detector: Integral, factory wired for single-point connection.

2.07 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
2. Greenheck Fan Corporation.
3. Pottorff.
4. Ruskin Company.

B. General Requirements:
1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.

C. Closing rating in ducts up to 6-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 3 hours.

E. Performance:
1. AMCA Certification: Test and rate in accordance with AMCE Publication 511.
2. Leakage:
a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:
1. Suitable or horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
a. Hat shaped.
b. Galvanized sheet steel, with welded corners and mounting flange.
c. Gauge is to be in accordance with UL listing.
4. Blades:
a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
b. Maximum width and gauge in accordance with UL listing.
5. Blade Edging Seals:
a. Silicone rubber.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
8. Bearings:
a. Stainless steel sleeve.

G. Mounting Sleeve:
1. Factory installed, galvanized sheet steel.
2. Length to suit wall or floor application.
3. Gauge in accordance with UL listing.

H. Heat-Responsive Device:
1. Electric resettable device and switch package, factory installed, rated.

I. Master control panel for use in dynamic smoke-management systems.

J. Damper Actuator - Electric:
1. Electric - Refer to controls specification section for more information.
2. UL 873, plenum rated.
3. Designed to operate in smoke-control systems complying with UL 555S requirements.
4. Two position with fail-safe spring return.
   a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
   b. Maximum 15-second full-stroke closure.
   c. Minimum 90-degree drive rotation.
5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.
7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 23 80 00 BAS.
2. Electrical Connection: 120 V, 60 Hz.

L. Accessories:
1. Auxiliary switches for signaling fan control or position indication.
2. Momentary test switch Test and reset switches, damper mounted.
3. Smoke Detector: Integral, factory wired for single-point connection.

2.08 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. DynAir; a Carlisle Company.

B. Description: roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.09 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pottorff.
2. Price Industries.
3. Ruskin Company.

B. General Requirements:
1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

C. Shape:
1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22 gauge thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20 gauge thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 18 gauge thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 16 gauge thick.

F. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 22 gauge thick, and with 1/8-inch- diameter perforations.

G. Special Construction:
1. Suitable for outdoor use.
2. High transmission loss.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:
1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.
a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.
3. Lining: None.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
1. Joints: flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Source Quality Control:
1. Test in accordance with ASTM E477.
2. Testing to be witnessed by Architect.
3. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
4. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.10 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. DynAir; a Carlisle Company.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:
   1. Double wall.

2.11 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. CL WARD & Family Inc.
   2. Ductmate Industries, Inc.
   3. Duro Dyne Inc.
   4. Nailor.
   5. Ruskin Company.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular. Minimum size as scheduled on the Drawings.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. 24-gauge- thick galvanized steel or 0.032-inch thick aluminum or 24-gauge- thick stainless steel door panel.
      d. Vision panel.
      e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      f. Fabricate doors airtight and suitable for duct pressure class.
      g. Knock-over tab frames are not permitted. Maximum leakage must not exceed British Standard DW144 Class A, B, and C. For access doors on reachable by ladder, provide a safety chain attaching the door to the duct.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
      a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum frame.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.
      d. Access Doors Larger Than 24 by 48 Inches: Continuous hinge and two compression latches with outside and inside handles.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. CL WARD & Family Inc.
   2. Ductmate Industries, Inc.
   3. Duro Dyne Inc.
   4. DynAir; a Carlisle Company.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

H. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

I. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd..
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

J. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.13 DUCT ACCESSORY HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. DynAir; a Carlisle Company.

B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.14 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire and smoke dampers in accordance with UL listing.

I. Connect ducts to duct silencers rigidly.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-ft. spacing.
   8. Upstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. For grease ducts, install at locations and spacing as required by NFPA 96.
   11. Control devices requiring inspection.
   12. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.

M. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIRE DAMPERS

A. Install within the thickness of the rated construction. Unless otherwise indicated on the drawings.

B. Verify accessibility of each fire damper through duct and building access panels, and operation of each fire damper by removing link and operating damper.

3.03 SMOKE DAMPERS

A. Install in accordance with conditions of UL listing.

B. Locate within 24" of the smoke barrier.

C. Install so that blades, when open, are no more than 5° off-axis with airflow.

D. Verify accessibility of each smoke damper through duct and building access panels, and operation of each smoke damper by removing operator and operating damper.

3.04 COMBINATION FIRE/SMOKE DAMPERS

A. Install within the thickness of the rated construction. Unless otherwise indicated on the drawings.

B. Install so that blades, when open, are no more than 5° off-axis with airflow.

C. Verify accessibility of each combination fire/smoke damper through duct and building access panels, and operation of each combination fire/smoke damper by removing link and operator and operating damper.

3.05 Manual dampers

A. Install dampers in accordance with manufacturer's instructions to operate freely.

B. Provide standoff brackets, sized to clear the insulation thickness, for quadrants installed on insulated ductwork.

3.06 CONTROL DAMPERS

A. Install dampers in accordance with manufacturer's instructions to operate and to obtain leakage rates specified herein. Adjust the damper linkage such that the damper closes before the actuator is fully closed to assure tight closure of the damper.

B. Blank-off and seal around dampers and between dampers and sleeves or frames to eliminate air bypass.

3.07 SMOKE DETECTORS

A. Duct-mounted smoke detectors shall be located as follows:
1. Within 60" of its respective smoke damper with no outlets or inlets between the detectors and damper.
2. Between the smoke damper and any duct opening or connection.
3. In a straight section of duct.

3.08 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 33 46 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Insulated flexible ducts.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.
   2. Product Data: For adhesives and sealants, indicating VOC content.
   3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
   4. Laboratory Test Reports: For insulation, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For flexible ducts.
   1. Include plans showing locations and mounting and attachment details.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.02 INSULATED FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. JP Lamborn Co.
   3. McGill AirFlow LLC.
   4. Thermaflex; a Flex-Tek Group company.
   5. Ward Industries; a brand of Hart & Cooley, Inc.

2.03 FLEXIBLE DUCT CONNECTORS

A. Clamps: in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Liquid adhesive plus tape.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts directly with rigid ductwork. Do not use flexible ducts.

D. Connect diffusers to ducts directly or with maximum 60 inches lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with liquid adhesive plus tape draw bands.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:
1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Provide hard elbows or three straight duct diameters at diffuser connections.
7. Bends in the flex duct shall be no less than one duct diameter centerline radius. Flex ducts shall extend a few inches past sheet metal prior to bending.

H. Supporting Flexible Ducts:
1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

SECTION 23 34 16 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Square in-line centrifugal fans.
   2. Tubular in-line centrifugal fans.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2. Rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Certified fan performance curves with system operating conditions indicated.
   4. Certified fan sound-power ratings.
   5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6. Material thickness and finishes, including color charts.
   7. Dampers, including housings, linkages, and operators.
   8. Fan speed controllers.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Sustainable Design Submittals:
   1. Product data showing compliance with ASHRAE 62.1.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions
   1. Base fan-performance ratings on the following:
      a. Ambient Temperature: 80 deg F.
      b. Altitude: 650 ft above sea level.
      c. Humidity: 67 deg F.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Startup."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.02 SQUARE IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerovent; a division of Twin City Fan Companies, Ltd.
2. Greenheck Fan Corporation.
3. Loren Cook Company.

B. Description: Square in-line centrifugal fans.

C. Housing:
1. Housing Material: Aluminum.
2. Housing Coating: None.
3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Bearings:
1. Heavy-duty regreasable ball or roller type
2. Bearing Rating Life: L10 at 80,000 hours hours.
3. Extend grease fitting to accessible location outside of unit.

F. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

G. Motor Enclosure: Totally enclosed, fan cooled.

H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.03 TUBULAR IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerovent; a division of Twin City Fan Companies, Ltd.
2. Greenheck Fan Corporation.
3. Loren Cook Company.

B. Description: Tubular in-line centrifugal fans.

C. Housing:
1. Housing Material: Aluminum.
2. Housing Coating: None.
3. Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct Drive

E. Bearings:
1. Heavy-duty regreasable ball or roller type
2. Bearing Rating Life: L10 at 80,000 hours hours.

3. Extend grease fitting to accessible location outside of unit.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Motor Enclosure: Totally enclosed, air over.

H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.04 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerovent; a division of Twin City Fan Companies, Ltd.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. New York Blower Company (The).

B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, belt- driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Fan and all additional components shall be UL762 rated for kitchen exhaust applications.

C. Housings:
1. Housing Material: Stainless Steel continuously welded.
2. Housing Coating: None.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Coated steel angle member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of eight discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

D. Wheels:
1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: Steel.
a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8 Type B.
3. Wheel and Blade Coating: None.
4. Backward-Inclined Airfoil Blades:
a. Aerodynamic design.
b. Heavy backplate.
c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

E. Shafts:
1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed. Shaft shall be a minimum of 1-1/8"

F. Bearings:
1. Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.
2. Bearing Rating Life: L10 at 80,000 hours hours.
3. Extend grease fitting to accessible location outside of unit.

G. Belt Drive:
1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: 1.5.

3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," 0.146 inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Motor Enclosure: Totally enclosed, fan cooled.

I. Accessories:
1. Inlet and Outlet: Flanged.
2. Access Door: Hinged gasketed door in scroll with latch-type handles.
3. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
4. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
5. Grease Collection Trough and Receiver: For restaurant exhaust application.
6. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.05 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.06 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

D. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:
1. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
2. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

E. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation and seismic-control devices.
1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

2. Comply with requirements in Section 23 05 48.13 "Vibration Controls for HVAC."

F. Install units with clearances for service and maintenance.

G. Label fans according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

H. Install centrifugal fans with a minimum of 2.5 duct diameters of straight duct at the inlet.

I. Ducts shall be aligned within +/- 3/8" tolerance with fan inlets and outlets.

3.02 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

D. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing according to Section 23 05 33 "Heat Tracing for HVAC Piping."

3.03 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.04 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.05 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.

9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.06 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.07 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.08 FIELD QUALITY CONTROL

A. Testing Agency: will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Modulating, single-duct air terminal units.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:
   1. Product Data: For adhesives, indicating VOC content.
   2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   3. Product data showing compliance with ASHRAE 62.1.

C. Shop Drawings: For air terminal units.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. Instructions for resetting minimum and maximum air volumes.
      b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.02 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Anemostat Products; a Mestek company.
   2. Nailor Industries Inc.
   3. Price Industries.

B. Titus; brand of Johnson Controls International plc, Global Products.Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22-gauge- thick galvanized steel.
   1. Casing Liner: mesh
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket. Provide 10x10 access panel between reheat coil and damper. Provide access door after reheat coil as well.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings. Solid shaft
   1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity inlet sensors.

F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings. Provide 0.025" copper tubing. Coils shall be leak testing at 315 psig minimum. Coils shall have NPT connections

G. Electronic Controls:
   1. Electronic Damper Actuator: Refer to controls specification section for more information.
   2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
   3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet.

H. Direct Digital Controls:
   1. Terminal Unit Controller: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, integrated actuators, and room sensors to be furnished under Section 23 80 00 BAS.

I. Control Sequence: See Section 23 80 06 "Sequence of Operation for HVAC" for control sequences.

2.03 SOURCE QUALITY CONTROL

A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.

B. AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.

C. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment" and Section 23 31 13 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

D. Install wall-mounted thermostats.

3.02 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties," and connect heating coils to supply piping with shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

3.03 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 23 31 13 "Metal Ducts" for connecting ducts to air terminal units.

B. Install access door after reheat coil as well as between the reheat coil and damper

3.04 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.06 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows, and coil type. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.07 ADJUSTING

A. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.08 FIELD QUALITY CONTROL

A. Testing Agency: will engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 57 00 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes shell-and-tube heat exchangers.

1.03 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
   2. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room plan or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Product Certificates: For each type of shell-and-tube heat exchanger. Documentation that shell-and-tube heat exchangers comply with "TEMA Standards."

C. Source quality-control reports.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Heat exchangers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Component Importance Factor is 1.5.

2.02 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Fluid Technology.
   2. Bell & Gossett; a Xylem brand.
   3. Spirax Sarco Limited.
   4. Taco Comfort Solutions.

B. Description: Packaged assembly of tank, heat-exchanger coils, and specialties.

C. Construction:
1. Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
2. Fabricate and label shell-and-tube heat exchangers to comply with "TEMA Standards."

D. Configuration: U-tube with removable bundle.

E. Shell Materials: Steel.

F. Head:
1. Materials: Fabricated steel with removable cover.
2. Flanged and bolted to shell.

G. Tube: Seamless copper tubes.
1. Tube diameter is determined by manufacturer based on service.

H. Tubesheet Materials: Steel.

I. Baffles: Steel.

J. Return water shall enter in the lower tube port.

K. Head gaskets shall be low leakage similar to Flexitaulic ZG or equivalent.

L. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
1. NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
2. NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

M. Support Saddles:
1. Fabricated of material similar to shell.
2. Fabricate foot mount with provision for anchoring to support.

2.03 ACCESSORIES

A. Hangers and Supports:
1. Supports and saddles to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.

B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF HEAT EXCHANGER, GENERAL

A. Equipment Mounting:
1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

3.03 INSTALLATION OF SHELL-AND-TUBE HEAT EXCHANGER

A. Install heat exchangers on saddle supports.

B. Heat-Exchanger Supports: Mount heat exchanger on steel saddles and supports specifically designed for each heat exchanger.

C. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger saddles are anchored to building structure.

3.04 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for steam and condensate piping specified in Section 23 22 13 "Steam and Condensate Heating Piping" and Section 23 22 16 "Steam and Condensate Heating Piping Specialties."

C. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.

D. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

E. Install shutoff valves at heat-exchanger inlet and outlet connections.

F. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.

G. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.

H. Pipe pressure-relief valves, full size of valve connection, to floor drain.

I. Install vacuum breaker at heat-exchanger steam inlet connection.

J. Install hose end valve to drain shell.

K. Install thermometer on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 23 05 19 "Meters and Gages for HVAC Piping."

L. Install pressure gauges on each heat-exchanger fluid inlet and outlet piping and steam inlet piping. Comply with requirements for pressure gauges specified in Section 23 05 19 "Meters and Gauges for HVAC Piping."

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.

C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Heat exchanger will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 23 73 13.16 - INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components, including the following:
1. Casings.
2. Fans, drives, and motors.
3. Coils.
4. Pleated panel filters
5. Cartridge filters
6. Air filtration section.
7. Dampers.
8. Antimicrobial ultraviolet (UV) lamp systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
a. Include certified fan-performance curves with system operating conditions indicated.
b. Include certified fan-sound power ratings.
c. Include fan construction and accessories.
d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.
1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For **, s**upports**,** and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for selecting **,** supports, and seismic restraints and for designing vibration isolation bases.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.07 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.
1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design vibration isolation [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg .

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buffalo Air Handling.
2. Carrier Corporation.
3. Daikin Applied.

4. Dunham-Bush, Inc.
5. Trane.
6. YORK; a Johnson Controls company.

2.03 UNIT CASINGS

A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.

B. Base Rail:
1. Material: Galvanized steel .
2. Height: 6 inches .

C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.

D. Double-Wall Construction:
1. Outside Casing Wall:
a. Material, Galvanized Steel: Solid, minimum 22 gauge thick.
b. Material, Stainless Steel: Solid, type 304, minimum 22 gauge thick.
c. Material, Aluminum: Solid, minimum 0.040” thick.
2. Inside Casing Wall:
a. Material, Galvanized Steel: Solid, minimum 22 gauge thick.
b. Material, Stainless Steel: Solid, type 304, minimum 22 gauge thick.
c. Material, Aluminum: Solid, minimum 0.040” thick.

E. Floor Plate:
1. Material, Aluminum: Checkered plate, minimum 18 gauge thick.
2. Material, Stainless Steel: Checkered plate, minimum 18 gauge thick.

F. Casing Insulation:
1. Materials: Injected polyurethane foam insulation .
2. Casing Panel R-Value: Minimum R-15 .
3. Insulation Thickness: 2 inches .
4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

G. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

H. Panels, Doors, and Windows:
1. Panels:
a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least24 inches wide by full height of unit casing up to a maximum height of 60 inches.
2. Doors:
a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
3. Windows:

a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
b. Size: Minimum [**6 inches**] <**Insert dimension**>, square or round.

4. Service Lights: LED vaporproof luminaire with individual switched junction box located outside , adjacent to each access door and panel.
   a. Locations: Each section accessed with door or panel .
5. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.
   a. Locations: Each section accessed with a door or panel .

I. Condensate Drain Pans:
1. Construction:
   a. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
2. Drain Connection:
   a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   b. Minimum Connection Size: NPS 1 .
3. Slope: Minimum 0.125-in./ft. slope , to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
4. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1(minimum 6”).
5. Width: Entire width of water producing device.
6. Depth: A minimum of 2 inches deep.
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.04 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.
1. Shafts: With field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway.
2. Shaft Bearings:
   a. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-10 rated life of 80,000 hours according to ABMA 9.
3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
   a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
5. Plenum Fan Arrays: Contained as defined in AHRI 430. Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide backdraft dampers at each fan to prevent short circuiting of flow if one fan is not operating.
6. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; steeloraluminum hub riveted to backplate and fastened to shaft with setscrews.
7. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steeloraluminum hub swaged to backplate and fastened to shaft with setscrews.
8. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

9. Shaft Lubrication Lines: Extended to a location outside the casing.
10. Flexible Connector: Factory fabricated with a fabric strip attached to two strips of galvanized steel sheet .
    a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
        1) Fabric Minimum Weight: 26 oz./sq. yd..
        2) Fabric Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
        3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F.

C. Drive, Direct: Factory-mounted, direct drive.

D. Motors:
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: Totally enclosed, fan cooled .
4. Motor Pulleys: Adjustable pitch for use with 5 -hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
6. Provide factory-installed shaft grounding rings for motors designed with variable frequency drives .
7. Mount unit-mounted disconnect switches on exterior of unit.

E. Comply with Section 232923 "Variable-Frequency Motor Controllers."

2.05 COIL SECTION

A. General Requirements for Coil Section:
1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.

B. Heating Coils:
1. Hot-Water Coils: .
    a. Piping Connections: Threaded or Flanged , same end of coil.
    b. Tube Material: Copper .
    c. Tube thickness: Minimum 0.035 inches.
    d. Fin Type: Plate.
    e. Fin Material: Aluminum .
    f. Fin Spacing: Maximum 10 fins per inch.
    g. Fin Thickness: 0.0095 inches.
    h. Rows: Maximum 8.
    i. Tube velocity: Minumum 2 fps at design condition.
    j. Fin and Tube Joint: Mechanical bond .
    k. Headers:
        1) Seamless copper tube with brazed joints, prime coated.
        2) Fabricated steel, with brazed joints, prime coated.
        3) Provide insulated cover to conceal exposed outside casings of headers.
    l. Frames: Channel frame, galvanized steel .
    m. Coil Working-Pressure Ratings: Equal to the specified pressure rating of the piping system in which the coil is installed .

C. Cooling Coils:

1. Chilled-Water Coil: .
   a. Piping Connections: Threaded , same end of coil.
   b. Tube Material: Copper .
   c. Tube Thickness: 0.035 inches.
   d. Fin Type: Plate.
   e. Fin Material: Aluminum .
   f. Fin Spacing: Maximum 10 fins per inch .
   g. Fin Thickness: 0.0095 inches.
   h. Fin and Tube Joint: Mechanical bond .
   i. Rows: Maximum 8.
   j. Tube velocity: Between 4-6 fps at design condition.
   k. Headers:
      1) Seamless copper tube with brazed joints, prime coated.
      2) Fabricated steel, with brazed joints, prime coated.
      3) Provide insulated cover to conceal exposed outside casings of headers.
   l. Frames: Channel frame, galvanized steel .
   m. Working-Pressure Ratings: Equal to the specified pressure rating of the piping system in which the coil is installed .

2.06 PLEATED PANEL FILTERS

A. Source Limitations: Obtain filters from single source from single manufacturer.

B. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters.

C. Manufacturers:
   1. Viledon MV85
   2. AAF VariCel VXL
   3. Equivalent

D. Performance:
   1. Filtration Efficiency, ASHRAE 52.2 MERV Rating:
   2. Energy Cost Index: Five star rating.
   3. Initial Air Pressure Drop: With face velocity of 500 fpm, clean filter pressure drop shall not exceed the following:
      a. MERV 8:
         1) Depth 2 Inches: 0.31 inch wg.
   4. Manufacturer-Recommended Final Air Pressure Drop: 1.0 inch wg.
   5. Pressure Differential without Failure: 2 inches wg.
   6. Temperature Rating: 200 deg F.

E. Certification:
   1. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).
   2. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.
   3. UL: UL 900 listed.

F. Size:
   1. Nominal size of individual filters indicated on Drawings:
   2. Nominal Filter Size:
      a. Face: 24 by 24 inches.
   3. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.

G. Filter Media Surface Area: Each filter shall contain the following minimum media surface area for a filter with a nominal 24-by-24-inch face:
   1. Depth 2 Inches: 17.3 sq. ft.

H. Construction:
   1. Media: Glass or cotton and synthetic blend of fibers arranged in a series of pleats attached to and supported by a corrosion-resistant welded-wire grid
   2. Filter Media Casing: High wet strength (28-point) beverage board that is bonded around the periphery to eliminate air bypass.

a. Diagonal support members across upstream and downstream filter face constructed of same material as casing shall ensure pleat spacing and stability.

3. Adhesive: Fire-retardant bonding adhesive where bonding media to casing.

2.07 CARTRIDGE FILTERS

A. Manufacturers:
1. Viledon MV85
2. AAF VariCel VXL
3. Equivalent

B. Source Limitations: Obtain filters from single source from single manufacturer.

C. Description: Factory-fabricated, dry, extended-surface, disposable, air filters with media formed in mini-pleats and arranged in a V-shape pattern.

D. Performance:
1. Filtration Efficiency, ASHRAE 52.2 MERV Rating: 14
2. Energy Cost Index: Five star rating.
3. Initial Air Pressure Drop: With face velocity of 500 fpm, clean filter pressure drop shall not exceed the following:
a. MERV 14: 0.27 inch wg.
4. Manufacturer-Recommended Final Air Pressure Drop: 1.5 inches wg.
5. Pressure Differential without Failure: 10 inches wg.
6. Temperature Rating: 175 deg F.

E. Certification:
1. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).
2. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.
3. UL: UL 900 listed.

F. Size:
1. Nominal Filter Size:
a. Face: 24 by 24 inches .
b. Depth: 12 inches.
2. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.

G. Filter Media Surface Area: Each filter shall contain at least 200 sq. ft. for a filter with a nominal 24-by-24-inch face.

H. Construction:
1. Media: Microfine glass media formed into mini-pleats and arranged in V-shape patterns.
2. Media Frame: Plastic or corrosion-resistant metal.
3. Adhesive: Fire-retardant bonding adhesive where bonding media to frame.

2.08 AIR FILTRATION SECTION

A. Front- or Back-Access Filter Mounting Frames:
1. Particulate Air Filter Frames: Galvanized-steel framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
a. Prefilters: Incorporate a separate 2-inch- thick track, with same access as primary filter.
b. Sealing: Full periphery foam gaskets.

2.09 DAMPERS

A. Dampers: Comply with requirements in Section 238001 "BAS Basic Materials and Devices"

B. Damper Operators: Comply with requirements in Section 238001 "BAS Basic Materials and Devives"

C. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

D. Combination Filter and Mixing Section:
   1. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
   2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.10 ANTIMICROBIAL ULTRAVIOLET (UV) LAMP SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Ultraviolet.
   2. Steril-Aire, Inc.
   3. UV Resources.

B. Source Limitations: Obtain lamp systems from single source from single manufacturer.

C. Description: UV-C lamp system consisting of power supply, wiring, lamp(s), plug(s), and holder(s) used for ultraviolet germicidal irradiation (UVGI) of cooling coil and condensate drain pan. Lamps shall have a Teflon sleeve to prevent shattering glass during breaking. All equipment shall be corrosion proof. UV lights shall provide 360-degree UV coverage for increased air treatment. The minimum intensity striking any point on a plane representing the surface of the coil or component shall not be less than 50 microwatts per square centimeter and average radiation shall be a minimum of 150 microwatts per square centimeter.
   1. Factory assembled and engineered by a qualified design professional.

D. Air-Handling Unit Factory Assembly:
   1. Install UV-C lamp systems in accordance with manufacturer's written instructions.
   2. Location: Install UV-C lamp system array immediately downstream of cooling coil bottom drain pan
   3. UV-C Lamp System Support Assembly: Aluminum or 300 series grade stainless steel framework rigidly attached to air-handling unit casing and adequately braced to provide ridge support of UV-C lamp systems that will not move or damage when leaned on or bumped into by operators.
   4. Service Access: Lamps shall be easily replaceable from inside the air-handling unit.
      a. Install access door(s) with window to access UV light. Treat each window and test to confirm UV emitted through the window is below the threshold limits of NIOSH and ACGIH.
      b. If adequate space is unavailable inside air-handling unit, install UV-C lamp systems on a slide out rail to allow lamp replacement from one exterior side of air-handling unit.
   5. Factory wire UV-C lamp systems internally and terminate at a disconnecting switch on the exterior of the air-handling unit casing on both sides of the cooling coil.
      a. Switch to include a lock-out/tag-out feature.
      b. In addition to disconnecting switch, provide each access door accessible to UV-C lamp systems with a position limit switch wired into UV-C lamp systems power circuit to de-energize power to UV-C lamp systems when door is opened.
   6. Install a caution nameplate at each UV-C lamp systems disconnecting switch that reads: "DANGER, UV LIGHTS - Turn off before entering."
   7. Protection from UV Damage: Materials in direct or indirect (reflected) contact with UV shall be tested and certified as UV tolerant. Any material not certified shall be completely shielded from UV using a certified UV-tolerant material such as metal. UV tolerance shall be capable of performing intended duty for a minimum of 20 years.
   8. Shipping: Remove UV-C lamps after factory testing; package and ship UV-C lamps in protective containers for field installation.
      a. Label exterior of enclosures with detailed description of container contents, including air-handling unit designation.
      b. Ship UV-C lamps for each air-handling unit in separate containers.

E. UV-C Lamp System Status Monitoring:

1. Sourcing: Furnished by UV-C lamp system manufacturer with UV-C lamp systems.
2. Monitors operating status of UV-C lamps by measuring change in electrical current.
3. On/off status of lamps displayed by LED lights on face of local display unit.

2.11 MATERIALS

A. Steel:
1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:
1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B 09.

E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000 -hour salt-spray test according to ASTM B117.
1. Standards:
a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross hatch adhesion of 5B.
2. Application: Spray.
3. Thickness: 1 mil .
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.12 SOURCE QUALITY CONTROL

Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. The owner and engineer will have the option to witness testing for both factory and field tests Standard Factory Tests: The fans shall be factory run tested to ensure structural integrity via deflection testing and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control prior to shipment.

A. Factory and Field Casing Leakage Test:
1. Perform leak testing of air-handling units that include factory and field assembly of multiple sections.
2. Leak test air-handling unit(s) of each unique size and arrangement randomly selected by Owner.
3. Follow procedures complying with ASHRAE 111.
4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.
5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Test report shall be in accordance with ASHRAE 111.

B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Equipment Mounting:
1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 23 05 48.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Drain Pan Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."
1. Make connections to air-handling unit connections with flanges or unions.
2. Extend drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
4. Install threaded cleanouts at changes in direction.

D. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.07 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.08 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. HEPA Filters: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
5. HEPA Filters, Critical Applications: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME AG-1, pressure-decay method.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 80 00 – BAS GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers, valves and devices to perform control sequences and functions specified. Refer also to control drawings, sequences of operation, and point lists.

B. The HVAC distributed digital control (DDC) and building automation system (BAS) defined in these specifications shall furnish and install a complete system utilizing the following:
   1. A BACnet based BAS utilizing ASHRAE 135 standard BACnet protocol. Towards this end, contractor shall provide all specified objects and services and have them configured/mapped as applicable.

C. The BAS defined in these specifications shall interface with an existing approved BAS servers located on UNC's network and operated by EMCS in the Giles Horney Building. Reference also controls drawings, sequences of operation, and point lists.

1.02 PROCUREMENT

A. The BAS and digital control and communications components installed under this contract shall be an integrated distributed processing system of the following manufacturer. No other vendor's products will be considered as substitutions.

B. Owner Preferred Alternates:
   1. Alternate No. M-01: furnish and install a BACnet based building automation system by Automatic Logic Controls (ALC).
   2. Alternate No. M-02: furnish and install a BACnet based building automation system by Schneider Electric (SE).

1.03 SUBMITTALS

A. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.
   1. Drawings and Diagrams: During the initial submittal approval process the drawings can be submitted in PDF format.

B. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions. System Architecture and System Layout:
   1. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. All optical isolators, routers, repeaters, end-of-line terminators, junctions, ground locations etc. shall be located on the diagram.
   2. Provide floor plans and vertical risers drawings locating all control units, workstations, servers, gateways, etc. Include all LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. All optical isolators, routers, repeaters, end-of-line terminators, junctions, ground locations etc. shall be located on the floor plans. All remote differential pressure transmitters and sensors (air or water) shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.

C. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.

D. All physical points on the schematic flow diagram shall be indicated with names and descriptors. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic

and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

E. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring which is existing, factory-installed and portions to be field-installed.

F. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

G. Sheets shall be consecutively numbered with Table of Contents listing sheet titles and sheet numbers, and legend and list of abbreviations.

H. Submittal Review Meeting:
1. The BAS Contractor will participate in a submittal review meeting at UNC with the Designer, Mechanical Contractor, CxA, UNC and other project members to review all submittal comments. The BAS engineer assigned to the project will be required to attend the meeting along with other necessary BAS contractor project members.
2. If substantial submittal review comments are made which require resolution subsequent resubmittal meetings may be required.

I. Control Drawings: Laminated 11 x 17 control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Drawings should be of sufficient size to be easily read. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.

J. Operation and Maintenance Materials:
1. Submit documents under provisions of Section _____ copies of the materials shall be delivered directly to the Owner's facilities operation staff along with an electronic (PDF format) version, in addition to the copies required by other Sections.
2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
3. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.
4. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

1.04 PROJECT RECORD DOCUMENTS

A. Record copies of product data and control shop drawings updated to reflect the final installed condition.

B. Record copies of approved control logic programming and database on paper and on CD's. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.

C. Record copies of approved project specific graphic software on CDs.

D. Provide as-built network architecture drawings showing all nodes, including Node ID and domain, sub-network and channel addresses.

E. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate drawing reference number.

F. Provide record riser diagram showing the location of all controllers.

G. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

1.05 WARRANTY MAINTENANCE

A. Contractor shall warrant all products and labor for a period of 1 year after Final Project Acceptance (usually 30 days after SCO beneficial occupancy).

B. The Owner reserves the right to make changes (set point changes, deadbands and tuning adjustments) to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

C. At no cost to the Owner, during the warranty period, the Contractor shall provide maintenance services for software, firmware and hardware components.

1.06 LISTING AND LABELING

A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

PART 2 - PRODUCTS

2.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

2.02 DIGITAL CONTROL PANELS AND LOCATION

A. Contractor shall locate BAS panels as referenced by the designer.

2.03 SURGE PROTECTION

A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all controllers, operator interfaces, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

2.04 CONTROL POWER SOURCE AND SUPPLY

A. General requirements for obtaining power include the following:

1. In the case where additional power is required beyond what is shown on the electrical plans, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.

2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer

3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 238001 – BAS BASIC MATERIALS AND DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wiring
B. Control Valves and Actuators
C. Control Dampers and Actuators
D. Control Panels
E. Sensors
F. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)
G. Transducers
H. Current Switches
I. Nameplates
J. Testing Equipment

1.02 DESCRIPTION OF WORK

A. Refer to Section 238000 for general requirements.
B. Refer to other Division-23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.
C. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
    1. Control wiring between field-installed controls, indicating devices, and unit control panels.
    2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
    3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
    4. All other necessary wiring for fully complete and functional control system as specified.

1.03 WORK BY OTHERS

A. Control Valves furnished under this section shall be installed under the applicable piping section under the direction of Section 230901 Contractor who will be fully responsible for the proper operation of the valve.
B. Control Dampers furnished under this section shall be installed under the applicable air distribution or air handling equipment section under the direction of Section 230901 Contractor who will be fully responsible for the proper operation of the damper
C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of Section 230901 Contractor who will be fully responsible for the proper installation and application.
D. All Controlled Equipment Power Wiring shall be furnished and installed under Division 16. Where control involves 120V control devices controlling 120V equipment, Division 16 Contractor shall extend power wiring to the equipment. Section 230901 Contractor shall extend it from the equipment to the control device. (i.e., Electrician installs power to motor, Controls Contractor wires relays, etc.)

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General: Provide electronic and electric control products in sizes and capacities indicated, consisting of valves, dampers, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. DEP Communications: Provide LonWorks or BACnet to Modbus TCP universal gateway to allow transmitting of BAS data to DEP control panel.

C. Communication Wiring: All wiring shall be in accordance with National Electrical Codes and Division 16 of this specification. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved by UNC. In addition, all wiring jackets shall be labeled "BAS" in 3 foot or fewer intervals along the length of the jacket material.
   1. Contractor shall supply all communication wiring between Controllers, Routers, BPOC(s) and LCS computer.
   2. Control LAN For any portions of this network required under this section of the specification, contractor shall use Category 5 or better cable as specified in TIA-568B. Media shall be Class 2 plenum rated and installed in accordance with manufacturer's recommendations. Network shall be run with no splices and separate from any wiring over thirty (30) volts.

D. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes and Division 16 of this Specification.
   1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
   2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

E. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification.
   1. Low voltage control wiring shall be minimum 18-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

F. Control Panels:
   1. Provide control panels with suitable brackets for wall mounting for each controlled system. Locate panel adjacent to systems served. Mount center of control panels 60" above finish floor or roof.
   2. Interior: Fabricate panels of 16-gage furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock keyed to the UNC Approved Control Panel Key, with manufacturer's standard shop- painted finish and color.
   3. Exterior: 16-gauge 304 Stainless Steel NEMA 4X enclosure. Panel shall have hinged door and keyed lock.
   4. Provide UL-listed cabinets for use with line voltage devices.
   5. To address shock hazard concerns, all terminals with a voltage higher than 24 V must either have shields installed to prevent contact or be 'finger proof' terminals.
   6. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.
   7. All gauges and control components shall be identified by means of nameplates.
   8. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
   9. Provide a 6"x6" metal wiring/tubing trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing

capacity. Wiring/tubing troughs shall not be less than 24" in length. Control panel wiring shall be installed and distributed in the trough to minimize routing of wiring and tubing within the control panel.

10. All controllers and panel mounted control devices shall be located in a single enclosure. Additional panels can be used to house the controllers and devices if all devices will not fit in a single, large control panel.
11. Complete 11x17 laminated wiring and tubing termination drawings shall be attached to the interior of each panel of sufficient size to be easily readable.

2.02 STANDARD SERVICE CONTROL VALVES

A. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

B. Plug-Type Globe Pattern for Water Service:
1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
3. Temperature Rating: 25°F minimum, 250°F maximum
4. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
5. Valve Trim: Bronze; Stem: Polished stainless steel.
6. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
7. Plug: Brass, bronze or stainless steel, Seat: Brass
8. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
9. Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
10. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Schneider Electric-TAC
    c. Warren
    d. Delta

C. Plug-Type Globe Pattern for Steam Service:
1. Valve Sizing: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
3. Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
4. Body: Bronze, screwed, 250 psig steam working pressure for 1/2" to 2"; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2" and larger for applications of 50 psig or less.
5. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
6. Packing: Spring Loaded Teflon.

7. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
8. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Schneider Electric-TAC
    c. Warren
    d. Delta

D. Butterfly Type: To be used for two-position control only, No Exceptions.
1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
4. Bearings: Bronze or stainless steel
5. Shaft: 416 stainless steel
6. Cold Service Pressure: 175 psi
7. Close Off: Bubble-tight shutoff to 150 psi
8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Owner.
9. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Jamesbury WS815
    b. Bray Series 31
    c. Invensys
    d. Dezurik BGS
    e. Siemens

E. Ball Type Characterized
1. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. Seat: Reinforced Teflon
3. Ball: Stainless steel.
4. Port: 'V' style.
5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. Cold Service Pressure: 600 psi WOG
7. Steam working Pressure: 150 psi
8. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
    a. Johnson Controls
    b. Belimo
    c. Conbraco
    d. Worcester
    e. Nibco
    f. Jamesbury
    g. PBM
    h. Invensys
    i. Delta

F. Pressure Independent Type
1. Valves shall be pressure independent and shall be used for Chilled Water service 2-1/2" and larger unless noted otherwise. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow. A flow tag, furnished with each valve shall list flows at all the valve positions in 10 degrees rotation increments. A maximum of 5 psi shall be required to operate the valve pressure independently. Electronic type PICV valve is not allowed for use.
    a. Rangeability: The valves shall have a turndown capability of at least 100:1.
    b. Body: Bronze, flanged, 125 psi maximum working pressure.

c. Operating Temperature: 250°F.

d. Pressure/Temperature ports (Pete's Plugs): Taps shall be installed at the factory in each valve to measure the pressure drop through the valves to determine the valve flow rate.

e. Acceptable Manufacturers: Subject to compliance with requirements. Approved manufacturers are as follows:
   1) Delta P Valve by Flow Control Industries, Inc.
   2) KTM valve by Flow Design.

G. Rotary Segmented Ball Type for Steam Pressure Regulating Service:
1. Characteristics: Modified equal-percentage characteristics with 300:1 rangeability.
2. Body: Steel, flanged, 150 psig steam working pressure.
3. Ball: Stainless steel segmented ball
4. Valve Trim and Stem: Stainless steel.
5. Packing: Spring Loaded Teflon.
6. Seat: Reinforced Teflon
7. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
   a. Fisher V150
   b. Valtek ShearStream
   c. Neles R-Series

2.03 CRITICAL SERVICE CONTROL VALVES

A. General: Provide factory fabricated control valves of type, body material and pressure class indicated on the 'Control Valve Specification Sheet' located at the end of this document. Contractor shall utilize the sheet to submit the control valves for the project. Valves shall be as manufactured by Fisher Controls International, Valtek Control Products, DeZurik/Copes-Vulcan, Leslie Controls Inc., or equal. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators and pilot positioners with proper close-off rating and capability for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

2.04 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable airflow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5" w.c. (622 Pa):
1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Galvanized steel maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.
4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
5. Jamb Seals: Stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.

8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than one percent based on approach velocity of 1500 ft./min. (7.62 m/s) and 1 inches wg. (249Pa).
10. Maximum Pressure Differential: 2.5 inches wg. (622 Pa)
11. Temperature Limits: -40 to 200 °F (-40 to 93 °C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.

C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1493 Pa):
1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.
4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
5. Jamb Seals: Stainless steel.
6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa).
10. Maximum Pressure Differential: 6 inches wg. (622 Pa)
11. Temperature Limits: -40 to 200 °F (-40 to 93 °C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.

D. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12" w.c.:
1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws
4. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
5. Linkage: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16" x3/4" (4.76 mm x 19 mm) minimum thickness tie rods.
6. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. Maximum Pressure Differential: 12 inches wg. (2984 Pa)
9. Temperature Limits: -40 to 300 °F (-40 to 149 °C).
10. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.

E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4" w.c. (994 Pa):
1. Performance: Test in accordance with AMCA 500.
2. Frames: rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.

3. Blades: Steel construction, 12 gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10 gauge minimum thickness for larger dampers.
4. Blade Seals: Full circumference neoprene.
5. Shaft: ½ inch (12.7 mm) diameter zinc or cadmium plated steel.
6. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
7. Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
8. Maximum Pressure Differential: 4 inches wg. (994 Pa)
9. Temperature Limits: -40 to 300 °F (-40 to 149 °C).

F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1492 Pa):
1. Performance: Test in accordance with AMCA 500.
2. Frames: rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch (4.76 mm) thick steel channel for larger sizes, galvanized or aluminum finish.
3. Blades: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch (6.35 mm) minimum thickness for larger dampers.
4. Blade stops: ½ inch x ¼ inch (12.7 mm x 6.35 mm) full circumference steel bar.
5. Blade Seals: Full circumference neoprene.
6. Shaft: zinc or cadmium plated steel, angle reinforcing as necessary.
7. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
8. Leakage: Less than 0.4 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
9. Maximum Pressure Differential: 6 inches wg. (1492 Pa)
10. Temperature Limits: -40 to 250 °F (-40 to 121 °C).

2.05 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Actuators
1. All actuators requiring greater than 150 inch/pounds of torque shall be provided as pneumatic actuators as defined below.
2. Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
3. Two Position Electric Actuators: Line voltage (120 volt, 24 volt) with spring return. Provide end switches as required.
4. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, or network connection as required. Actuators shall travel full stroke in less than 90 seconds (VAV terminal box actuators may be up to 300 second full stroke time). Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. When two non-networked actuators are required to operate in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
5. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.

6. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
   a. Siemens
   b. Schneider Electric-TAC DuraDrive
   c. Belimo
   d. Johnson Controls
   e. Delta

C. Quarter-Turn Actuators (for ball valves):
   1. Electric
      a. Motor: Suitable for 24, 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
      b. Gear Train: Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
      c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
      d. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning. For terminal zone reheat valves the actuators can fail in the last position.
      e. Enclosure: Exterior actuator enclosure shall be a NEMA-4 epoxy coated metal enclosure, and shall have a minimum of two threaded conduit entries.
      f. Limit Switches: Travel limit switches shall be UL and UNC approved. Switches shall limit actuator in both open and closed positions.
      g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
      h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger than 4" valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
      i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
      j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
      k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
      l. Ambient Conditions: Actuator shall be designed for operation from –140 to 150 °F ambient with 0 to 100 percent relative humidity.

2.06 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers. Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. Smart sensors or smart actuators shall meet all controller requirements in addition to the relevant sensor or actuator requirements.

C. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

D. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

E. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

F. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

2.07 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of controller, sensor range shall provide a resolution of no worse than 0.3°F (0.16 °C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. Matched Sensors: The following applications shall require matched sensors:
   1. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5% of span plus 0.1°C
   2. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature. Sensing element shall be platinum RTD guaranteeing an accuracy of +/- 0.5% of span plus 0.1°C

C. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 1.0°F accuracy at calibration point.
   2. Provide setpoint adjustment with initial normal setpoint 75°F cooling and 70°F heating and adjustable range of +/- 1°F. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS. Provide an occupancy override button on the room sensor enclosure. This shall be a momentary contact closure
   3. Provide current temperature indication via an LCD or LED readout.

D. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 or 304 stainless steel.
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point

E. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in Paragraph A.
   1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3°F accuracy at calibration point.

F. Liquid Immersion Temperature Sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15°F.
   1. Sensing element (chilled water/glycol systems) shall be thermistor or platinum RTD ±0.3 °C measured at 0 °C.

G. Outside Air Sensor: Shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, sensor range shall provide a resolution of no worse than ±0.1 °C measured at 10 °C.

2.08 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A

combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy(% RH): +/- 2% (when used for outside air, enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
3. Sensor Operating Range: As required by application
4. Long Term Stability: Less than 1% drift per year.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, Hy-Cal HT Series or approved equal.

2.09 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. General – For all hydronic Differential Pressure Transmitters, provide a 5 valve bypass assembly for connection between the DP transmitter and the piping system being monitored. The purpose of the connect is to allow air to be efficiently bled from the branch piping and also to allow for easy calibration of the DP transmitter via parallel connection of a test instrument at the "bleed" lines.

B. Water General Purpose:

1. General: Two wire transmitter, 4-20 mA or 0-5 volt for runs less than 100' output with zero and span adjustments.
2. Ambient Limits: –40 to 175 °F (-40 to 121°C), 0 to 100% RH.
3. Process limits: –40 to 250 °F
4. Accuracy: 0.5% overall accuracy,
5. Maximum Pressure Rating: 450 psig (3103 KPa) maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.
6. Kele & Associates Model 360 C, Approved Equal.

C. Water Critical Service:

1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 0-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
2. Ambient Limits: –40 to 175 °F (-40 to 121°C), 0 to 100% RH.
3. Process limits: –40 to 400 °F (-40 to 205°C).
4. Accuracy: less than 0.1%
5. Output Damping: Time constant user selectable from 0 to 36 seconds
6. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
7. Electrical Enclosure: NEMA-4, -4X, -7, -9.
8. Approvals: FM, CSA.
9. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa.

D. General Purpose Low Pressure Air: Generally, for each measurement of duct pressure, filter differential pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell-type transmitter.
2. Output: two wire 4-20 mA or 0-5 volt for runs less than 100' output with zero adjustment.
3. Overall Accuracy: Plus or minus 1%.
4. Minimum Range: 0.1 in. w.c.
5. Maximum Range: 10 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Units shall be Modus T30, Veris PX Series, or Dwyer Series 616. Substitutions shall be allowed per Division 1.
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

E. General Purpose Low Pressure/Low Differential Air: Generally, for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered, two-wire differential capacitance cell type transmitter.
   2. Output: Two-wire 4-20 mA or 0-5 volt for runs less than 100' output with zero adjustment.
   3. Overall Accuracy: Plus or minus 1%.
   4. Minimum Repeatability: +/-.25% of reading
   5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Modus T30. Substitutions shall be allowed per Division 1.
   8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
   9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

F. VAV Velocity Pressure: Generally, for use in variable volume air velocity pressure measurement where the range is applicable.
   1. General: Loop powered two-wire differential capacitance cell type transmitter.
   2. Output: Two-wire, 4-20 mA output with zero adjustment.
   3. Overall Accuracy: Plus or minus 0.25%
   4. Minimum Range: 0 in. w.c.
   5. Maximum Range: 1 inch w.c.
   6. Housing: Polymer housing suitable for surface mounting.
   7. Acceptable Manufacturers: Setra or Approved Equal. Substitutions shall be allowed per Division 1.
   8. Range: Select for minimum range that will accept the maximum velocity pressure expected.

2.10 AIRFLOW MEASURING STATIONS (AFMS)

A. Air Flow Traverse Probes – Minimum duct air velocity less than 400 fpm (especially for Outside Air measurement): Provide either of the following:
   1. Ebtron Gold Series GTC116-P+. The Air Flow Measurement Station (AFMS) shall use the principle of thermal dispersion with one self-heated and one-zero power bead-in-glass thermistor at each sensing node. Only the thermistor shall be located within the sensing node, all other electronic components shall be outside the airstream
      a. Sensor Accuracy: +/- 3% of reading when installed in accordance with the manufacturer's recommended sensor density and placement guidelines.
      b. Velocity Range: 0-5000 fpm
      c. Locate and install AFMS per manufacturer's recommendations.
   2. Tek-Air IAQ-TEK Series IAQ series. The number of Tamer Probes required shall be based upon the size and aspect ratio of the duct or other housing at the Probe location. Contractor to provide straight section meeting upstream and downstream requirements using air flow straighteners as needed and will verify transducer range
      a. Sensor Accuracy: 200-1000 fpm is ±5.0%, 75-200 fpm is ±10%
      b. Velocity Range: 75-1000 fpm
      c. Temperature Limits: -20°F to 200°F
      d. Probe Material: PVC/ABS plastic.
      e. Enclosure for Electronics: NEMA 4X
      f. Operating Range: Select minimum range to accommodate the expected flow range of the equipment.
      g. Manufacturer: Tek-Air Systems Inc. 'IAQ-Tek' Series IAQ2000.

2.11 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, calibration taps, and a bypass valve.

2.12 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service Auto Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static

pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal.

B. General Service Manual Reset - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing. Acceptable Manufacturer - Dwyer Series 1900 or equal.

C. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range and 0°F to 160°F operating temperature range.

2.13 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls. Substitutions shall be allowed per Division 1.

2.14 CURRENT SWITCHES (CS)

A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
1. Range: 1.5 to 150 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Lower Frequency Limit: 6 Hz.
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED, or approved equal.

B. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; RE Technologies RCS 1150 or approved equal.
1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
1. Range: 1.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Frequency Range: 5-75 Hz
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: Veris Industries, Inc. H-904, or approved equal.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break

and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.15 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)
   1. Range: 1-10 amps minimum, 20-200 amps maximum
   2. Trip Point: Adjustable
   3. Output: 0-5 VDC.
   4. Accuracy: ±0.2% from 20 to 100 Hz.
   5. Acceptable Manufacturers: Veris H221, KELE SA100 or approved equal.

2.16 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. Pressure sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306. Substitutions shall be allowed per Division 1.

B. Low Air Pressure Surge Dampener: 30-second time constant. Acceptable manufacturer shall be Modus SD030. Substitutions shall be allowed per Division 1.

2.17 INSERTION TYPE TURBINE METER FOR WATER SERVICE

A. Turbine Insertion Flow Meter sensing method shall be impedance sensing (iron magnetic and non-photoelectric), with volumetric accuracy of +/- 2% of reading over middle 80% of operating range, and +/- 4% of reading over the entire operating range. Turbine Insertion Flow Meter shall have maximum operating pressure of 400 psi and maximum operating temperature of 200°F continuous (220°F peak). All wetted metal parts shall be constructed of 316 stainless steel. Flow meter shall meet or exceed all of the accuracy, head loss, flow limits, pressure and material requirements of the AWWA standard C704-70 for the respective pipe or tube size. Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0-10 V, and current output of 4-20 mA.
   1. Install in water systems with a minimum of 10 pipe diameters unobstructed flow. Double turbine insertion required at between 10 and 4 diameters unobstructed flow.
   2. Acceptable Manufacturers: Onicon Corp. and Hersey. Substitutions shall be allowed per Division 1.

2.18 CO_2 SENSORS/TRANSMITTERS (CO_2)

A. CO_2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.

B. Accuracy: ±36ppm at 800 ppm and 68°F.

C. Stability: 5% over 5 years.

D. Output: 4-20 mA, 0-10 Vdc or relay.

E. Mounting: Duct or Wall as indicated.

F. Calibration Kit – Provide 1 calibration kit for a project that contains at least 1 CO_2 sensor. Kit shall include 2 CO_2 calibration gas cylinders; one 200 ppm and one 1000 ppm, gas regulator, tubing, and fittings, adapters, sensor cones etc. for the application.

2.19 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.

B. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.
   1. Coil Enclosure: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.

2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 °F (66 °C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
3. Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker. Substitutions shall be allowed per Division 1.
4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. Low Temperature Detector ('Freezestat') (FZ): Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPDT (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F (-9.4 to 12.8°C), factory set at 38°F.

D. High Temperature Detectors ('Firestat') (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F (-4 to 102°C).

E. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150° F (10 to 65°C) , and a minimum 10°F fixed setpoint differential.

F. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed contacts, operating temperature range of 50 to 90°F (10 to 32°C), switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

G. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
   a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
   b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
   c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
   d. Pilot light indication of power-to-coil and coil retainer clips.
   e. Coil rated for 50 and 60 Hz service.
   f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA or approved Equal.
2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
4. All safety circuits shall be installed to operate individual interposing relays located in the associated equipment control panel. Each safety device (i.e. Freezestat, DP safety, smoke detector, firestat, etc.) wiring circuit shall be installed with individual homeruns back to the associated control panel. See control drawings for details.

H. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse. Substitutions shall be allowed per Division 1.

I. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall have replaceable fuses in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure. Transformers shall be sized so that the connected load does not exceed more than 75% of the manufacturer's stated rating.
1. Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson. Substitutions shall be allowed per Division 1.

J. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
   1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
   2. TDRs shall be UL and CSA listed, Crouzet type. Substitutions shall be allowed per Division 1.

K. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.

L. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

M. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory. Substitutions shall be allowed per Division 1.

N. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

2.20 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

C. Provide nameplates riveted to ceiling grid for terminal equipment or controllers located above accessible ceilings.

2.21 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.
   1. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed.

Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 16 of this Specification.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All control network wiring shield shall be terminated as recommended by controller manufacturer. All control network wiring shall be labeled with a network number, NodeID at each termination and shall correspond with the network architecture and floor plan submittals.
5. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Provide rigid conduit at all exterior locations and where subjected to moisture. All conduits penetrating partitions, walls or floors shall be sealed with a submitted and approved non-hardening putty material to prevent migration of air through the conduit system.
6. Communication cabling shall be provided in an UNC approved color dedicated to the BAS.
7. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

C. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

D. Room Temperature Sensors: Mount 48" above finished floor.

E. Averaging Temperature Sensors: Cover no more than two square feet per linear foot of sensor length except where indicated. Generally, where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.

F. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

G. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

H. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

I. Water Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter and for parallel connection of calibration/ test instrument.

J. Pipe Immersion Temperature Sensors: Install a "P/T" port directly next to EACH immersion sensors installed for the project. The Pressure/Temperature test port shall have ¼" or ½" MPT brass body, dual durometer EPDM core, threaded brass cap with o-ring seal and neoprene retainer strap and shall accept standard 1/8" gauge adapter or thermometer stem. Rated to 500 PSI / 3450 kPa, and 250ºF / 120ºC. Pressure/Temperature Test Port shall be PTV ENTERPRISES Model PT or approved equal.

K. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

L. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

M. Supply Duct Pressure Transmitters:
   1. General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install static pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration. Provide a capped "T" in line with the pneumatic sensing line for parallel connection of calibration/ test instrumentation. Alternatively, proved a test port in the duct directly next to the DP transmitter sensing location.
   2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 3/4 of the hydraulic distance to the most remote terminal in the air system where shown on the drawings. Provide a capped "T" in line with the pneumatic sensing line for parallel connection of calibration/ test instrumentation. Alternatively, proved a test port in the duct directly next to the DP transmitter sensing location.

N. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

END OF SECTION

SECTION 23 80 02 – BAS FIELD PANELS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions. Control Panels

PART 2 - PRODUCTS

2.01 STAND-ALONE FUNCTIONALITY

A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller.

B. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller's standalone functionality:
   1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
   2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
   3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
   4. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices. All wiring to interconnect the I/O expander board shall be:
      a. Contained in the control panel enclosure.
      b. Or run in conduit. Wiring shall only be accessible at the terminations.

D. Alternate Configuration:
   1. Multiple controllers may be provided to control a single unit or other complete system if the provided Building Automation System manufacturer does not have a single controller (with or without expansion modules) that can be provided to meet the single unit/ system point count.
   2. In this instance, multiple controllers may be provided as long as each controller is still "stand-alone". All points required to execute any subroutine or PID Loop type control shall be contained in a single controller.

2.02 CONTROLLERS

A. General Requirements for all Controllers:
   1. Controller shall have hardware I/O to support the application. Controller's hardware I/O shall meet the following requirements:
      a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a manual hand off or auto switch to allow for override. Each DO shall be discrete outputs from the controller board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

b. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the controller board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.
c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the controller and shall be isolated from the main board.
d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
e. Electronic Analog Outputs (AO) as required by application: voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Where floating control is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. In addition, use of floating control without any feedback of actual output device position requires the capability to periodically re-zero the output device. Pulse Width Modulated (PWM) analog via a DO and transducer is acceptable only with Owner approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each AO shall be discrete outputs from the controller board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 8 bits.

2. Shall be mounted on equipment, in packaged equipment enclosures, or wall mounted in a locking NEMA 1 enclosure, as specified elsewhere.

B. Terminal Box Controllers:
1. Terminal box controllers (Direct Digital Air Volume System) controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible, the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

2.03 CONTROL PANELS

A. Provide control panels with suitable brackets for wall mounting for each controlled system. Locate panel adjacent to systems served. Mount center of control panels 60” above finish floor or roof.

B. Interior: Fabricate panels of 16-gage furniture-grade steel, totally enclosed on four sides, with removable perforated backplane, hinged door and keyed lock keyed to the UNC Approved Control Panel Key, with manufacturer's standard shop- painted finish and color.

C. Exterior: 16-gauge 304 Stainless Steel NEMA 4X enclosure. Panel shall have hinged door and keyed lock.

D. Provide UL-listed cabinets for use with line voltage devices.

E. To address personnel shock hazard concerns: All terminals with a voltage higher than 30 volts must either have shields installed over exposed terminals or be ‘finger proof’ terminals to prevent inadvertent contact.

F. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.

G. All gauges and control components shall be identified by means of nameplates.

H. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.

I. If needed for cable and tubing management provide a 6”x6” metal wiring/tubing trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring and tubing capacity. Wiring/tubing troughs shall not be less than 24” in length. Control panel wiring shall be installed and distributed in the trough to minimize routing of wiring and tubing within the control panel.

J. All controllers and panel mounted control devices shall be located in a single enclosure. Additional panels can be used to house the controllers and devices if all devices will not fit in a single, large control panel.

K. Complete 11x17 laminated wiring and tubing termination drawings shall be attached to the interior of each panel of sufficient size to be easily readable.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS:

A. General: Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings. Contractor shall install all controllers in accordance with manufacturer’s installation procedures and practices.

3.02 RE-ZERO FUNCTION FOR FLOATING CONTROL WITHOUT FEEDBACK

A. Where floating control is used without actuator feedback, contractor shall program an automatically initiated function that resets the actuator to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. This function may be either programmed in the individual controllers, or resident elsewhere on the network as a supervisory control program, or some combination of the two. In any case, not more than 5% of the total quantity of controllers in a building shall perform this function at the same time. When possible, the controllers shall perform this function when the duct or pipe controlled by the actuator is not operating or is serving unoccupied zones.

3.03 HARDWARE APPLICATION REQUIREMENTS

A. Standalone Capability: Each controller shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated controller with only the exceptions enumerated below.

END OF SECTION

SECTION 23 80 03 – BAS COMMUNICATIONS

PART 1 - GENERAL

1.01 EMCS GATEWAY (BUILDING POINT OF CONNECTION - BPOC)

A. The EMCS Gateway shall be the gateway/router between the building controllers and EMCS server.

B. The gateway shall perform information translation between the Primary LAN and the Local Supervisory LAN, which is 100/1000 Mbps Ethernet TCP/IP and shall utilize BACnet over IP.

C. The BAS contractor will provide a controls gateway (BPOC), the gateway will be either;
   1. Johnson Controls NAE gateway communicating with the existing Metasys virtual server located at UNC ITS. The NAE(s) will be provided with 3 years of free upgrades following the installation date
   2. Schneider Electric Struxureware Automation Server (AS) communicating with an existing Struxureware virtual server located at UNC ITS. The AS(s) will be provided with 3 years of free upgrades following the installation date.
   3. Automated Logic WebCTRL gateway communicating with an Automated Logic WebCTRL virtual server located at UNC ITS. The building WebCTRL gateway will be provided with 3 years of free upgrades following the installation date.

D. The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply. Each gateway/router shall be mounted in a lockable enclosure.

E. Upon loss of power to the Gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

1.02 NETWORK COMMUNICATIONS

A. BACnet IP, ARCnet, or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
   1. IP
      a. The network shall use Cat5e or greater cabling for connections.
      b. Custom-made patch cables must use either the T568A or T568 wiring standard and must use the same standard on both ends of the cable.
   2. ARCNET
      a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100-120 ohms nominal. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)
      b. The maximum length of an ARCnet segment is 610 meters (2000 ft) with AWG 22 cable.
      c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
      d. An ARCnet network shall have no T connections
      e. ARCnet must be terminated on each segment end with proper current limiting resistors across A/+ B/- or devices with internal switchable EOL, for proper operation
      f. A PROT485 for surge protection at each place wire enters or exits the building and within 250 feet (76 meters) of every controller. No hard grounds shall be present.
   3. MS/TP
      a. The network shall use shielded, balanced twisted-pair cable with characteristic impedance between 100 and 120 ohms, balanced. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
      b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
      c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.

d. An MS/TP EIA-485 network shall have no T connections.
e. MS/TP must be terminated on each segment end with proper current limiting resistors across A/+ B/- or devices with internal switchable EOL, for proper operation
f. Ensure cable shield is connected to hard ground at only one point on the bus segment and is completely isolated from hard ground at all other points, failure to do so can great a ground loop and communication issues.

1.03 VFD NETWORK REQUIREMENTS

A. Variable frequency drives shall include a ASHRAE 135 standard BACnet protocol connection being used by the BAS network.

B. The drive shall have the capability of allowing the BAS to monitor feedback process variable feedback such as, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), fault conditions and codes and drive temperature.

1.04 CONSTRUCTION SERVER

A. During construction, vendor must deploy an isolated and secured network which does not rely on the building's network (BAS Construction Network) for project controls startup and commissioning. The construction server shall be loaded with full project graphics with all needed trends setup.

B. BAS Construction Network must allow communication between all BAS controllers and a temporary BAS server (BAS Construction Server) via BACnet/IP, MS/TP or ARCnet.

C. BAS Construction Server must be securely accessible via the public internet and access must be restricted to authorized individuals. All authorized individuals must all have a legitimate association with the project in question.

D. BAS controllers must not be directly exposed to the public internet. These controllers must only be accessible to other devices on the same private network (the BAS Construction Server must therefore be on the same private network).

E. The BAS Construction Server shall only be accessed via the public internet via HTTPS with a valid certificate issued by a publicly-recognized certificate authority (CA).

1. The BAS Construction Server may be exposed to other levels of access from the public internet with sufficient security safeguards in place. These safeguards must include more than simple username and password authentication. (E.g. two-factor authentication, source IP address filtering, etc.

PART 2 - PRODUCTS

2.01 OPERATOR INTERFACE GRAPHIC SOFTWARE (GENERAL)

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS

A. General: Install and configure EMCS gateway(s) to provide interface between the UNC EMCS VLAN and an existing approved vendor's virtual server located at UNC ITS and the building control network. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Ensure that gateway(s) combined network usage on the control network does not exceed the 30% bandwidth utilization.

B. After project acceptance, UNC will provide the permanent Gateway IP network drop used for a single point of connection to the BAS VLAN.

C. Provide all interface devices and software to provide an integrated system and coordinate with all other Divisions of the Specifications and suppliers to assure all systems are interoperable and data specified provided.

D. Coordinate closely with EMCS (Owner) to obtain IP addresses, BACnet ID (Device Object Identifiers), i.e., Instance numbers and network communications information to assure proper operation of the building control system with the UNC EMCS VLAN.

E. Gateways shall be capable of synchronizing time with a UNC time server. The Gateway shall be capable of pushing correct time to any controller with a real time clock.

F. Use Local Data Points for network communication. The use of External Data Points for integration is not permitted.

G. BPOC shall be configured to provide alarm information for the following events:
   1. Any control network fault.
   2. Any communication error on the control network.

END OF SECTION

SECTION 23 80 04 – BAS SOFTWARE AND PROGRAMMING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

A. Fully configure systems and furnish and install all software and programming for a complete and fully functioning system as specified.

PART 2 - PRODUCTS

2.01 SYSTEM SOFTWARE-GENERAL

A. Functionality and Completeness: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified.

B. Configuration: The software shall support the system as a distributed processing network configuration.

2.02 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be either user configurable or user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. Graphical Block Programming: Manipulation of graphic icon ‘blocks’, each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
2. Functional Application Configuration: For air terminal units only, pre-programmed application specific programs that allow/require limited customization via ‘fill-in-the-blanks’ edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.03 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. All alarms and events shall be routable to the UNC EMCS.

2.04 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

1. Provide ten-minute, 3 day minimum historical trends easily accessible from the BAS graphics for all physical (AI, AO) analog and related setpoints. Provide the capability, but do not activate historical trends for ALL physical digital (DI, DO) points, virtual points and calculated variables. All binary trends can be recorded in change-of-value (COV) format.

B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than five second increments for verification of control loop performance.

2.05 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

2.06 OVERRIDES

A. BAS shall provide an audit log report of all overrides currently active and historical overrides along with the user who initiated the override.

2.07 POINT STRUCTURING AND NAMING

A. General: The intent of this section is to require a consistent means of naming points across the UNC EMCS VLAN. Contractor shall configure the systems from the perspective of the UNC EMCS VLAN, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The convention is tailored towards the UNC EMCS VLAN and as such, the interface shall always use this naming convention, any deviations from this naming convention shall be approved by the Owner. Each controller shall have English language descriptors for all system points, variables, parameters etc. located and accessible form the controller memory. All point naming shall match between all system files and record documents.

B. Point Summary Table
   1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
   2. With each schematic, Contractor shall provide a Point Summary Table listing:
      a. Building Designator
      b. Building Name
      c. System Description
      d. Point ID
      e. Point Type
      f. Full point name (see Point Naming Convention paragraph)
      g. English language point description
      h. The BAS Contractor shall coordinate with the Owner's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.

PART 3 - EXECUTION

3.01 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming. Generally, meet the intent of the written sequences of operation. It is the Contractor's responsibility to request clarification on sequence issues that require such clarification.

B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.

C. All programming, user interfaces and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of the Owner and shall remain on the workstation(s)/server(s) at the completion of the project.

END OF SECTION

SECTION 23 80 05 – BAS OPERATOR INTERFACE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The scope of this section is to provide BAS graphics, alarming, scheduling and trending.

PART 2 - PRODUCTS

2.01 OPERATOR INTERFACE GRAPHIC SOFTWARE (GENERAL)

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above.

B. Dynamic Data Displays: Dynamic physical point values shall automatically updated at a minimum frequency of 12 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, offline or loss of communications, override and alarm conditions.

C. Point Override Feature: Each displayed point shall be individually enabled/disabled to allow mouse-driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be reported as an alarm and shall be displayed in a coded color on the BAS graphic screens for that applicable system. The alarm message shall include the operator's username. A list of points that are currently in an override state shall be available through menu selection.

2.02 GRAPHIC SOFTWARE (DESIGN REQUIREMENTS)

A. Floor Plan Layout Graphics:
1. Provide floor plan graphics for all areas/ floors served by BAS controlled equipment
2. Provide links from large floor plans to smaller, more detailed graphics (Zoom in feature).
3. Locate all controlled or monitored equipment on the floor plan graphics with a link to the equipment.
4. Show locations of all terminal unit Zone Sensors on the floor plans,
5. Areas served by zone level equipment shall be clearly delineated and color coded. Color coding shall be chosen so that adjacent zones are different colors or, are clearly outlined to designate the area served by the equipment. This is especially important when a zone includes multiple rooms.
6. Ensure room numbers reported on the floor plan graphics match the room number signage locate at each room. These numbers may or may not correspond to the numbers presented on the contract documents. This contractor is responsible for coordinating with the owner to verify final room numbering signage.
7. Review the floor plan layout design with the owner prior to installation on the server. This contractor is responsible for coordinating and receiving acceptance of the graphic layout design from the Owner.

B. Equipment Graphics (General):
1. All specified I/O points for the unit shall be shown on the graphic.
2. In addition, display all setpoints for any controlled components on the graphic. The setpoint shall be changeable from the graphic interface
3. Provide a link and description of any "Parent" equipment feeding the equipment/unit that is controlled by the BAS. Also, provide the current primary value of the service being provided. i.e.: For an AHU, provide a link to the ChW & HW systems providing heating and cooling water to the unit on the unit's graphic. Next to the link, display the current supply temperature.
4. For any equipment that has remotely located sensors, the graphic for that unit shall contain a detailed description of the location of the sensor (i.e. down duct static pressure

sensors, remote hydronic DP sensors, etc.). Ideally, provide the actual room number where the sensor is located and any other descriptive information (above ceiling, etc.)

5. Provide and install an electronic version of the as built control schematics on the gateway server. Provide a link to the electronic control schematics on each major equipment page.

C. Terminal Unit Graphics:
   1. All specified I/O points for the unit shall be shown on the graphic.
   2. In addition, display all setpoints for any controlled components on the graphic. The setpoint shall be changeable from the graphic interface.
   3. Provide a table of all VAVs by a AHU listing zone temperature, air flow, damper position, HW valve position, terminal discharge air temperature, heating and cooling demand.
   4. Provide a table of exhaust terminals by EF system listing air flow, damper position and command
   5. Provide a link and description of any “Parent” equipment feeding the terminal unit. Also, provide the current primary value of the service being provided. i.e.: For a VAV box, provide a link to the AHU providing supply air to the terminal unit on the terminal unit’s graphic. Next to the link, display current the supply air temperature. Similarly, provide a link to the HW system and the HW Supply temperature. This applies to all terminal equipment and to any unit that is served by another system (i.e. AHUs, Energy Recovery Systems, etc.).

2.03 OPERATOR INTERFACE ALARM AND EVENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to the LCS operator interface. At no time shall the ability to report alarms be affected by either operator activity at the LCS, or by communications with other panels on the network.

B. Alarm Descriptor: Each alarm or point change shall include that point’s English language description, and the time and date of occurrence. In addition to the alarm’s descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.

C. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with UNC on establishing alarm priority definitions.

D. Alarm Acknowledgment: For alarm priority levels directed to the LCS, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and username of acknowledging operator) shall be stored in a selected file on the LCS hard disk.

E. It shall be possible for any operator to receive a summary of all alarms regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; alarm priority; and notification class.

F. Typically, alarms will be specified in the sequence of operations or the control system logic diagrams. However, alarm points shall be as dictated by the owner. The following guide is presented for use in further determining what points to initially set up for any given system/ equipment/ unit, etc. This contractor shall coordinate all alarm requirements with the owner. For systems not listed here, the requirements should be extrapolated from similar systems that are listed. The minimum alarm requirements for the systems listed below are as follows:
   1. Standard AHU Alarms:
      a. Fan Failure --- should reference command
      b. Pump Failure --- should reference command
      c. Freeze stat --- alarm enabled at all times

d. Fire Alarm --- alarm enabled at all times
e. Hi Fan Static --- alarm enabled at all times
f. Filter Alarm --- alarm enable at all times
g. Damper Status --- smoke dampers controlled by fire alarm system --- alarm enable at all times
h. Damper Status --- smoke and isolation dampers controlled by BAS system ---- alarm disabled when system is shutdown.
i. Mixed air temp below 40 on units without preheat, no alarm on units with preheat and minimum OA requirements - alarm enabled at all times
j. Preheat temp below 40 on units with preheat --- alarm enabled at all times
k. Zone temps below 65 or above 83 with 2 degree differential and an occupancy schedule ---- alarm @ 65 normal at 67 and alarm at 83 normal at 81
l. Zone temps below 67 or above 80 with 2 degree differential and no occupancy schedule---- alarm @ 67 normal at 69 and alarm at 80 normal at 78
m. Discharge temps 2 degrees above and below the min and max reset set points if using resets 1 degree differential, set up warning to indicate temp 1 degree off of set point for more than 5 minutes --- alarm disabled when system is shut down and have a 5 minute delay after system restarts.
n. Duct Static pressures should alarm when more than a .25 inch or 10% off of set point --- alarm disabled when system is shut down and have a 5 minute delay after system restarts.
o. Space or return humidity above 60% or below 30% (DLAM area only) with a 5% differential --- alarm @ 60% normal at 55% and alarm at 30% normal @ 35%--- alarm enabled at all times
p. Discharge humidity above 90% --- alarm enabled at all times
q. Return temp above 80 or below 68 with 2 degree differential --- alarm @ 80 normal at 78 and alarm at 68 normal at 70 --- alarm disabled when system is shut down and have a 30 minute delay after system restarts.
r. Building Static pressure above 0.05 and below -0.005 with 0.0 in wg differential --- alarm @ 0.05 normal at and alarm at 0.0 normal at 70 --- alarm enabled at all times on a 180 second time delay.
s. Chill water supply above 50 with 3 degree differential

2. Standard ERU and EF Alarm:
   a. Fan Failure --- should reference command
   b. Pump Failure --- should reference command
   c. Fire Alarm --- alarm enabled at all times
   d. Hi Fan Static --- alarm enabled at all times
   e. Filter Alarm
   f. Damper Status --- smoke dampers controlled by fire alarm system --- alarm enable at all times
   g. Damper Status --- smoke and isolation dampers controlled by BAS system ---- alarm disabled when system is shutdown.
   h. Duct Static pressures should alarm when more than a 1/4 inch off of set point --- alarm disabled when system is shutdown and have a 5 minute delay after system restarts.
3. Standard Hot Water System Alarms:
   a. Pump Failure --- should reference command
   b. Low steam pressure alarm --- alarm enabled at all times
   c. Make up water flow alarm ---- alarm enabled at all times
   d. Low system pressure alarm --- alarm disabled when system is shutdown
   e. Hot water supply temps should alarm above 200 degrees and should give us a warning if more than 5
   f. degrees off of set point for more than 5 minutes - alarm disabled when system is shutdown and have a 15 minute delay after system restarts.

g. System pressures should alarm when more than a 2 PSID off of set point --- alarm disabled when system is shutdown and have a 5 minute delay after system restarts.

4. Standard Vav Zone Alarms:
   a. Zone temps below 65 or above 83 with 2 degree differential and an occupancy schedule ---- alarm @ 65 normal at 67 and alarm at 83 normal at 81
   b. Zone temps below 67 or above 80 with 2 degree differential and no occupancy schedule---- alarm @ 67 normal at 69 and alarm at 80 normal at 78
   c. Supply air flow alarm --- alarm 10% above or below flow set point with 5% differential --- lab boxes only ---alarm disabled when system is shut down and have a 5 minute delay after system restarts.
   d. Exhaust air flow alarm --- alarm 10% above or below flow set point with 5% differential --- lab boxes only--- alarm disabled when system is shut down and have a 5 minute delay after system restarts.
   e. Space humidity above 60% or below 30% with a 5% differential --- alarm @ 60% normal at 55% and alarm at 30% normal @ 35%--- alarm enabled at all times
   f. Box discharge temp below 55 with 2 degree differential --- alarm @ 55 normal @ 57

2.04 OPERATOR INTERFACE TRENDING

A. The LCS shall be able to display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

B. Provide trends for all physical points, setpoints, other virtual points (as indicated) and calculated variables. A minimum of 80% of the systems AI/AO trends can be active without impacting remote data access performance.

C. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. Displayed trend graphs shall indicate the engineering units for each trended value.

D. The sample rate (up to 5 second interval) and data selection shall be selectable by the operator.

E. The trended value range shall be selectable by the operator.

F. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

G. Trending Requirements: All I/O points on primary equipment shall be trended throughout the Cx process on 10 min. intervals for analog values and change-of-value for binary values.

H. A total of 1 week of data (minimum) shall be stored locally at the controller/ gateway. Older data shall be archived to the central server by the BAS.

I. All trends shall be accessed from the user graphic displayed I/O point, not only through a trend menu.

2.05 OPERATOR INTERFACE EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

2.06 GATEWAY/BPOC

A. Furnish and install all Routers and Gateways/ Building Point of Connection (BPOC) gateways as required for the BAS to function locally. One VLAN connection will be provided to the LCS for connectivity of the OI.

2.07 SUBMITTALS

A. Electronic Submittals: While all requirements for hard copy submittal apply, these control submittals shall also be provided in electronic format as follows:

1. Graphic Files: Graphic drawings shall be provided on electronic media as an Acrobat PDF. Each unique graphic shall be represented one time. This submittal must be approved by the Owner 60 days prior to the start of commissioning activities.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 23 80 06 - BAS SEQUENCE OF OPERATIONS

PART I. PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air Handling Units

B. Hydronic Systems

C. Terminal Units

D. Exhaust Fans

1.02 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including the General Conditions and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.

B. Section 23 80 00 - Building Automation System (BAS) General

C. Section 23 80 01 - BAS Basic Materials, Interface Devices, and Sensors

D. Section 23 80 02 - BAS Field Panels

E. Section 23 80 03 - BAS Communications

F. Section 23 80 04 - BAS Software and Programming

1.03 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function.

1.04 SUBMITTALS

A. Refer to Section 23 80 00 and Division 1 for requirements for control shop drawings, product data, User's Manual, etc.

B. Programming Manual: Provide DDC system programming manual as well as documentation of site-specific programming prior to the start of Acceptance Phase.

1.05 PROJECT RECORD DOCUMENTS

A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual setpoints and tuning parameters as existed at acceptance.

B. Record documents shall be modified control drawings with the actual installed information. Drawings shall be delivered in both reproducible hard copy and

electronic format in AutoCAD 2002 drawing files. Provide all supporting files, blocks, fonts, etc. required by the drawings.

C. Provide final points list as described above

D. Provide final detailed wiring diagrams with all wire numbers and termination points indicated

E. Accurately record final sequences and control logic made after submission of shop drawings.

PART II. PART 2 PRODUCTS (NOT APPLICABLE)

PART III. PART 3 EXECUTION

3.01 GENERAL

A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.

B. When an air handling unit is not in operation, control devices shall remain in their “off” positions. “Off” positions may differ from the “normal” (meaning failed) position. Except as specified otherwise, “off” and “normal” positions of control devices shall be as follows:

Device	“Off” Position	“Normal” Position
Heating coil valves	closed	open
Cooling coil valves	closed	closed
Steam coil valves	closed	closed
Outside air damper	closed	closed
Return air damper	open	open
Exhaust/relief air damper	closed	closed

C. Variable Frequency Drives: For a VFD dependent on an external input for its output setting (e.g. the VFD gets “Frequency” as an input), loss of that external input shall result in the VFD holding its last value. If the VFD is running its own PID loop and the external input to the VFD is a setpoint (e.g., duct static pressure setpoint), the VFD shall hold the last setpoint. If the VFD loses its process variable (e.g., duct static pressure), the VFD shall go to its minimum speed setting.

D. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified “proportional only” or “P+I”, Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.

E. Provide a real time clock and schedule controller with sufficient scheduling capability to schedule all required controllers and sequences. Schedule functionality may reside in BPOC or a controller. If BPOC is used, document scheduling functionality on BPOC submittal, if a controller is used, document scheduling functionality including SNVT names and types on controller points list submittal. Set up initial schedules in coordination with UNC.

F. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:
   1. Occupied Period: period of time when the building is in use and occupied. Unless indicated otherwise, this period is defined as 7:00 AM – 10:00 PM weekdays and 8:00 AM to 5:00 Saturdays. Exclude all national holidays. Generally systems will be fully operational throughout this period and ventilation air shall be continuously introduced. Space temperature setpoints will generally be in the “normal” range of 69°-77°F.
   2. Unoccupied period: period of time when the building or zone is not in use and unoccupied. Ventilation air shall not be introduced.

G. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.

H. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level, from the LCS via an LNS plug-in or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

I. When a power failure is detected in any phase, the BAS start commands shall be retracted immediately from all electrically powered units served by the failed power source. If the associated controller is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the controller is powered by uninterruptible power supply (UPS), or if it is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable) per building. When the BAS detects that normal or emergency power has been restored, all equipment for which the BAS start command had been retracted shall be automatically restarted in an orderly manner on staggered 5 second intervals to minimize inrush current.

J. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:
   1. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
   2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
   3. Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.

K. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:
   1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., space temperature) setpoint. The reset increment

shall be determined by the quantity of “need heat” or “need cool” requests from individual SCU’s. A SCU’s “need heat” virtual point shall activate whenever the zone’s space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A SCU’s “need cool” virtual point shall activate whenever the zone’s space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.

L. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method shall be employed:
   1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g., cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. The BAS analog output value shall be acceptable as indicating the position of the control device.
   2. Alternatively, to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point shall increment by one unit each time a zone’s valve/damper position rises to greater than 95%. The quantity of “need heat” or “need cool” points shall then be the basis for reset.

M. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS shall, after an adjustable time delay after the device is commanded to operate (feedback delay) , confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm shall be enunciated audibly. [Upon failure, run command shall be removed and the device shall be locked out until the alarm is manually acknowledged unless specified otherwise.]

N. BAS shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
   1. Speed control of variable speed drives
   2. Control Reset Loop
   3. Valve Travel Limit

O. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

3.02 AIR HANDLING UNITS - GENERAL

A. Logic Strategies: The BAS shall fully control the air handlers. Generally, the BAS shall energize the AH (start the fans and activate control loops) as dictated for each air handler. The following indicates when and how the BAS shall energize the AHs and

control various common aspects of them. The following “logic strategies” shall be included by reference with each air handler with any specific clarifications required:

1. Scheduled Occupancy: BAS shall determine the occupancy periods (occupied, unoccupied, and setback) as defined below. The following details the common control aspects related to the scheduled occupancy.
    a. Occupied Mode: BAS shall energize the AHU in the Occupied Mode during all occupied periods. Note that the beginning of the occupancy period shall be set sufficiently before the actual start of occupancy to obtain the required building component of ventilation per ASHRAE 62. Specific times shall be as directed by the Owner.
    b. Unoccupied Mode: Unless stated otherwise, the unit shall be disabled during the unoccupied period unless the setback mode conditions are met, as detailed below. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.
    c. Setback Mode: Whenever the setback mode conditions are met the unit shall be energized in the Unoccupied Mode (minimum OA flow rates/ damper position shall be 0).
        1) The unit shall enter the setback mode if any of the following occur while the unit is in the Unoccupied Mode for 1 minute (adj.):
            a) OA Temperature drops below 32°F
            b) OR, the space temperature drops below 64°F
            c) OR, the zone humidity rises above 58%
        2) Once the AHU enters setback mode, it shall remain in the Setback Mode until the start of the next occupied schedule.
2. OA Control: During the occupied period, applicable dampers shall be modulated to maintain an OA flow rate setpoint. Setpoint shall be reset between min and max CFM as indicated on the Drawings. The OA flow rate shall be measured directly by an OA flow station.
3. Airside Economizer: BAS shall modulate the mixing dampers to provide “free cooling” when conditions merit. The free cooling shall generally be staged before any mechanical cooling. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable. All AHUs that utilize an Economizer mode shall utilize the Dry Bulb Switch strategy. Economizer mode shall be active while:
    a. The unit is energized and proven ON
    b. AND
        1) the global signal from EMCS indicating that Economizer Mode is Active (it shall fail OFF upon a loss of communications)
        2) OR, then the outside air temperature falls below the switching setpoint of 63°F (adj.) (with 2°F (adj.) cycle differential - Enable at 63°F, Disable at 65°F). The system shall utilize the EMCS Global OA Temperature reading. If there is a loss of communications with the EMCS Global OA Temperature, the BAS shall utilize the building’s local OA Temperature.
    c. AND, any preheat valve output (where applicable) is less than 5% open
4. Sequenced Heating and Cooling: BAS shall control the heating and cooling coils and air side economizer as detailed for the particular AH. Program logic shall directly prohibit the heating and cooling valves as well as the heating valve and

economizer damper to be open (or above minimum) simultaneously. This does not apply to cooling and reheat valves that are used simultaneously for dehumidification.

5. Mixed Air Low Limit Override: BAS shall override the signal to the OA damper via a linear reset loop output from 100% to 0% as mixed air temperature falls from 47°F to 42°F (loop shall output 0% at 42°F which shall be passed to the output via a low selector).
6. Freeze Safety: Upon operation of a freezestat, unit shall be deenergized with the exception of the heating loops. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock, [, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms]. OA dampers shall close, RA dampers shall open, all hydronic valves shall open and heating loops shall remain active.
7. Smoke Safety: Upon indication of smoke by a smoke detector, BAS shall deenergize the AH. Smoke detector shall notify the fire alarm system, shut down the fans, and close the smoke dampers via hard-wired interlock.
8. High or Low Pressure Safety: Upon activation of a high or low pressure safety switch, AH shall be deenergized, fans shall be deenergized via a hard wired interlock, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command], [which shall initiate "fan failure" alarms.

B. The detailed “logic strategies” above shall be required by reference to them in each of the individual sequences specified below.

3.03 AIR HANDLING UNIT – B – 1 (M702 & M703)

A. General: The BAS shall fully control the air handler. For details on the referenced logic strategies refer to Paragraph 3.2, Air Handling Units - General. Air handler control logic strategies shall include:
   1. Scheduled occupancy.
   2. Dry bulb switch economizer control.
   3. Sequenced heating and cooling coil valve control.
   4. Outside air damper control.
   5. Mixed air low limit.
   6. High and Low Pressure Safety.
   7. Freeze Safety.
   8. Smoke Safety.

B. Supply Fan: BAS shall control the starting and stopping of the supply fan array as follows:
   1. Start/Stop: BAS shall command the operation of the supply fans and they shall run continuously whenever the AHU is enabled (via a command to the supply fans’ VFD) as specified above and for the applicable logic strategies specified in Paragraph 3.2, Air Handling Units - General.
   2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of a supply fan, BAS shall enunciate an alarm as specified above. Separate fan status and proof alarms shall be provided for each fan in the fan array. Whenever all of a unit's supply fans are assessed as failed, the unit shall be assessed as failed. The unit will be disabled and locked out and the supply and return Fire/Some dampers shall close. A manual reset will be required via the BAS before the unit is allowed to restart automatically.
   3. VFD Control: Whenever the fans are energized and at least 1 fan’s status is

proven ON, the BAS shall control the speed of the VFDs per the lower of the following:

a. A PID loop output to maintain the lowest supply duct static pressure at setpoint. The static pressure setpoint shall initially be set at 2.0” wg (adj. as determined by the balance contractor).
b. A PID loop output to limit the highest supply duct static pressure at the duct static pressure setpoint + 1.0”w.c. (adj.).

4. Supply Duct Pressure Setpoint: Setpoint shall be reset between the limits of .5" to 2" as pressure requests of the VAV boxes at 4 with all values adjustable. BAS shall utilize a Sample and Bump output strategy or other similar loop output or logic to rest the static setpoint. Reset values shall be adjusted for optimized building and energy performance.
5. VFD BACNET Interface: BAS shall monitor the VFD via a BACNET interface. All available information shall be accessible via the interface for display on the VFD graphic. BAS shall also accumulate energy consumption of the fan motor (KWH) on a daily, monthly & yearly basis. BAS shall display KWH values for the following:
    a. KWH day to date (total for the day)
    b. KWH previous day
    c. KWH week to date
    d. KWH previous week
    e. KWH year to date
    f. KWH previous year

C. Relief Damper: BAS shall modulate the relief damper to maintain a 0.04” w.c. (adj.) building pressure input.
D. Return/OA Dampers: BAS shall control the dampers as follows:
    1. Closed: When AH is deenergized, dampers shall remain in their “off” positions. When AH is energized during unoccupied period the minimum OA flow setpoint will be 0 cfm which will close the minimum OA damper unless economizer is available.
    2. OA Control: During the occupied period when the AHU is proven ON, the BAS shall modulate the outside air damper to maintain outdoor airflow setpoint. The setpoint shall be reset between an "MINIMUM OA CFM " and a "MAXIMUM OA CFM" as scheduled. The setpoint will be reset based on a PID output in response to a space CO2 setpoint of 1,000 ppm (adj.).
    3. Economizer: BAS shall modulate dampers per the dry bulb switch economizer strategy detailed above. When enabled in the Economizer mode, the BAS shall control the Maximum OA damper and the Return Air damper per the lower of:
        a. A PID loop output to maintain the mixed air temperature at setpoint. The mixed air temperature setpoint shall be equal to the discharge air temperature setpoint (specified herein) minus 3°F
        b. AND, a proportional only loop output that decreases from 100% to 0% open as the Mixed Air Temperature drops from 47°F to 42°F
E. Space Temperature Control: The space temperatures shall be controlled via individual VAV boxes. The setback setpoint for cycling the unit shall be 65°F (adj.) for heating and 80°F (adj.) for cooling. Ensure that these setpoints are outside the control range of all box control loops.
F. Discharge Temperature Control: The discharge temperature setpoint shall be set as follows:
    1. The BAS shall calculate the result of temperature reset loop which will be a

proportional only loop output reset from 58°F to 65°F (both adjustable) as the return air temperature drops from 75°F to 70°F (both adjustable). The output of this above loop shall input to a dehumidification loop as the high limit of its reset range.

2. A dehumidification loop shall be A Proportional only loop output reset from 55°F (adj.) to the high limit output from the temperature reset loop (as described above) as the return air humidity rises from 54% to 58% (both adjustable).
3. The resultant temperature output after passing through the two loops (as described above) shall be the effective discharge temperature setpoint. This value shall be trended, alarmed and shown on the BAS graphic.
4. When the unit is energized for setback heating during the unoccupied period, the discharge temperature setpoint shall be 75°F (adj.)

G. Preheating Section:
1. HW Heating Valve: Whenever AHU is energized, N.O. valve shall modulate per the higher of
a. a PID loop to maintain a leaving temperature of the discharge air temperature setpoint of 52°F (adj.) and
b. a proportional only loop that outputs a value of 0-100% as the heating coil leaving temperature drops from 45°F(adj.) to 40°F(adj.).
2. Heating water circulating pump shall be started when outside air temperature drops below 45°F and stopped when outside air temperature rises above 50°F. Pump shall also be enabled anytime the unit freezestat trips.

H. Cooling Section:
1. Cooling Coil Valve: N.C. cooling coil valve shall modulate via a DA PID loop to maintain discharge temperature setpoint. During unoccupied period.
2. If AHU is energized for heating, or warm-up, the cooling coil valve shall remain closed.
3. If Outside Air Temperature is less than 53°F (adj.), the cooling coil valve shall remain closed.
4. Cooling coil shall be disabled if the heating valve is opened more than 5%.

I. UV Lights: UV lights should be enabled at all times, no BAS interface for control is desired. If access section doors are opened, a local switch will disable UV lights. However, BAS shall monitor status, not via a light level measurement but instead by a current measurement. If a bulb is out, indicate on BAS.

3.04 AIR HANDLING UNIT – 3 – 1 (M704 & M705)

A. General: The BAS shall fully control the air handler. For details on the referenced logic strategies refer to Paragraph 3.2, Air Handling Units - General. Air handler control logic strategies shall include
1. Scheduled occupancy.
2. Dry bulb switch economizer control.
3. Sequenced heating and cooling coil valve control.
4. Outside air damper control.
5. Mixed air low limit.
6. High and Low Pressure Safety.
7. Freeze Safety.
8. Smoke Safety.

B. Supply Fan: BAS shall control the starting and stopping of the supply fan array as follows:
1. Start/Stop: BAS shall command the operation of the supply fans and they shall

run continuously whenever the AHU is enabled (via a command to the supply fans' VFD) as specified above and for the applicable logic strategies specified in Paragraph 3.2, Air Handling Units - General.

2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of a supply fan, BAS shall enunciate an alarm as specified above. Separate fan status and proof alarms shall be provided for each fan in the fan array. Whenever all of a unit's supply fans are assessed as failed, the unit shall be assessed as failed. The unit will be disabled and locked out and the supply and return Fire/Some dampers shall close. A manual reset will be required via the BAS before the unit is allowed to restart automatically.

2. VFD Control: Whenever the fans are energized and at least 1 fan's status is proven ON, the BAS shall control the speed of the VFDs per the lower of the following:
   a. A PID loop output to maintain the lowest supply duct static pressure at setpoint. The static pressure setpoint shall initially be set at 2.0" wg (adj. as determined by the balance contractor).
   b. A PID loop output to limit the highest supply duct static pressure at the duct static pressure setpoint + 1.0"w.c. (adj.).

3. Supply Duct Pressure Setpoint: Setpoint shall be reset between the limits of .5" to 2" as pressure requests of the VAV boxes at 4 with all values adjustable.

4. VFD BACNET Interface: BAS shall monitor the VFD via a BACNET interface. All available information shall be accessible via the interface for display on the VFD graphic. BAS shall also accumulate energy consumption of the fan motor (KWH) on a daily, monthly & yearly basis. BAS shall display KWH values for the following:
   a. KWH day to date (total for the day)
   b. KWH previous day
   c. KWH week to date
   d. KWH previous week
   e. KWH year to date
   f. KWH previous year

C. Relief Fan: BAS shall control the starting and stopping of the relief fan as follows:

1. Start/Stop: The BAS shall command the operation of the Relief fan to maintain building pressure at setpoint. An appropriate amount of derivative gain or a ramp function shall be employed to prevent overshoot of the building pressurization setpoint. The fan shall be controlled as follows:
   a. Fan Start: The fan shall be enabled whenever the building pressure exceeds 0.06"w.c. (adj.).for more than 2 minutes (adj.).
   b. Fan Stop: The fan shall be disabled whenever the building pressure is below 0.02"w.c (adj.) AND the building pressurization loop output has been at 0% for 5 minutes (adj.). The relief fan shall always be commanded off if the unit is off.

2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of the relief fan, BAS shall enunciate an alarm.

3. Building Pressure Control: Whenever the relief fan is energized and fan status is proven ON, the BAS shall control the speed of the VFD to maintain the building pressure at setpoint. Initial setpoint shall be 0.04"w.c. (adj.). On start and stop, the VFD shall ramp to speed and slow down within adjustable acceleration and deceleration limits. BAS shall monitor a common alarm output from the drive (via the direct interface) and enunciate an alarm when an alarm is indicated.

4. VFD Interface: BAS shall monitor the VFD via a direct interface. All available information shall be accessible via the interface for display on the VFD graphic. BAS shall also accumulate energy consumption of the fan motor (KWH) on a daily, monthly & yearly basis. BAS shall display KWH values for the following:
    a. KWH day to date (total for the day)
    b. KWH previous day
    c. KWH week to date
    d. KWH previous week
    e. KWH year to date
    f. KWH previous year

D. Return/OA Dampers: BAS shall control the dampers as follows:
1. Closed: When AH is deenergized, dampers shall remain in their “off” positions. When AH is energized during unoccupied period the minimum OA flow setpoint will be 0 cfm which will close the minimum OA damper unless economizer is available.
2. OA Control: During the occupied period when the AHU is proven ON, the BAS shall open the outside air dampers to maintain outdoor airflow setpoint . The setpoint shall be reset between an "MINIMUM OA CFM " and a "MAXIMUM OA CFM" as scheduled. The setpoint will be reset based on a PID output in response to a space CO2 setpoint of 1,000 ppm (adj.).
3. Economizer: BAS shall modulate dampers per the dry bulb switch economizer strategy detailed above. When enabled in the Economizer mode, the BAS shall control the Maximum OA damper and the Return Air damper per the lower of:
    a. A PID loop output to maintain the mixed air temperature at setpoint. The mixed air temperature setpoint shall be equal to the discharge air temperature setpoint (specified herein) minus 3°F
    b. AND, a proportional only loop output that decreases from 100% to 0% open as the Mixed Air Temperature drops from 47°F to 42°F

E. Space Temperature Control: The space temperatures shall be controlled via individual VAV boxes. The setback setpoint for cycling the unit shall be 65°F (adj.) for heating and 80°F (adj.) for cooling. Ensure that these setpoints are outside the control range of all box control loops.

F. Discharge Temperature Control: The discharge temperature setpoint shall be set as follows:
1. The BAS shall calculate the result of temperature reset loop which will be a Proportional only loop output reset from 58°F to 65°F (both adjustable) as the return air temperature drops from 75°F to 70°F (both adjustable). The output of this above loop shall input to a dehumidification loop as the high limit of its reset range.
2. A dehumidification loop shall be A Proportional only loop output reset from 55°F (adj.) to the high limit output from the temperature reset loop (as described above) as the return air humidity rises from 54% to 58% (both adjustable).
3. The resultant temperature output after passing through the two loops (as described above) shall be the effective discharge temperature setpoint. This value shall be trended, alarmed and shown on the BAS graphic.
4. When the unit is energized for setback heating during the unoccupied period, the discharge temperature setpoint shall be 75°F (adj.)

G. Preheating Section:
1. HW Heating Valve: Whenever AHU is energized, N.O. valve shall modulate per the higher of

a. a PID loop to maintain a leaving temperature of the discharge air temperature setpoint of 52°F (adj.) and
b. a proportional only loop that outputs a value of 0-100% as the heating coil leaving temperature drops from 45°F(adj.) to 40°F(adj.).

2. Heating water circulating pump shall be started when outside air temperature drops below 45°F and stopped when outside air temperature rises above 50°F. Pump shall also be enabled anytime the unit freezestat trips.

H. Cooling Section:
1. Cooling Coil Valve: N.C. cooling coil valve shall modulate via a DA PID loop to maintain discharge temperature setpoint. During unoccupied period.
2. If AHU is energized for heating, or warm-up, the cooling coil valve shall remain closed.
3. If Outside Air Temperature is less than 53°F (adj.), the cooling coil valve shall remain closed.
4. Cooling coil shall be disabled if the heating valve is open more than 5%.

I. UV Lights: UV lights shall be enabled at all times, no BAS interface for control is desired. If access section doors are opened, a local switch will disable UV lights. However, BAS shall monitor status, not via a light level measurement but instead by a current measurement. If a bulb is out, indicate on BAS.

3.05 SINGLE DUCT VAV BOX (WITH HW REHEAT CONTROL) (M709 & M710)

A. General: Control shall be pressure independent with minimum and maximum flow setpoints, scheduled occupancy with optimum preoccupancy and occupancy override. VAV box shall be assigned to one of a minimum of 5 scheduling groups per air handler. Where multiple VAV boxes serve one zone with a common temperature sensor, all boxes serving this zone shall modulate airflow and reheat coil to control to a common discharge air setpoint.

B. Space Temperature Control: Three setpoints shall apply. Normal (73°F adj.)), setback heating (66°F (adj.)), and setback cooling (83°F). These three values shall be the only values changed by the operator to adjust space temperatures. All other deadbands, differentials, etc. shall be calculated in the program logic (unless another means is provided to prohibit overlap of the heating and cooling loops and ensure a dead band such as function block templates that restrict the setpoint input). During the normal periods, separate heating and cooling setpoints shall be calculated.
1. Normal space cooling setpoint: shall be the normal space temperature plus 2°F (adj.)
2. Normal space heating setpoint: shall be the normal space temperature minus 2°F (adj.)

C. Zone Damper: Zone damper shall modulate in a PI loop to maintain zone volume setpoint. Zone volume setpoint shall be reset as follows:
1. Cooling: The zone volume setpoint shall be reset between the minimum and the cooling maximum volume settings to maintain the space temperature at the cooling space temperature setpoint via a PID loop output. The zone volume setpoint shall be reset linearly between the minimum and cooling maximum volume setpoints on a loop output of 0 to 100%.
2. Heating: The zone volume setpoint shall be reset between the minimum and the heating maximum volume settings to maintain the space temperature at the heat space temperature setpoint via a PID loop output. Note that a common space heating PID loop output will be used to reset the zone volume setpoint (in the heating mode) and the HW reheat valve (see below). The zone volume setpoint shall be reset linearly between the minimum and heating maximum volume

setpoints on a loop output of 25 to 100% (adj.).

3. Dead band: When the space temperature is between the effective space temperature heating and cooling setpoints (heating and cooling PID outputs are both at 0%), the zone volume setpoint shall remain at the minimum flow setpoint.
4. Zone Volume setpoints shall be as scheduled on the drawings.

D. Hydronic Reheat (M709): N.O. Zone reheat coil valve shall modulate in a PID loop output (same loop output that resets the volume setpoint in the heating mode) to maintain the space temperature at the heating setpoint as defined above. The valve shall modulate from 0 to 100% on a PID loop output of 0-75% (adj.). The valve shall be closed whenever the parent air system is off.

E. Hydronic Reheat (M710): N.O. Zone reheat coil valve shall modulate in a PID loop output (same loop output that resets the volume setpoint in the heating mode) to maintain the space temperature at the heating setpoint as defined above. Each terminal unit valve shall modulate to maintain the same supply temperature. Supply temperature shall reset based on a PID loop from 55°F to 85°F(adj.).

F. Pressure Request: This terminal shall issue a “pressure request” whenever the zone damper output is greater than 90% open, with a 5% hyst.

G. Space Ventilation Override: Some zones include carbon dioxide monitoring only to satisfy LEED requirements. However, some other zones, as indicated on the drawings as having carbon dioxide sensors that are utilized for demand control ventilation as required by ASHRAE 90.1 with this feeback indicating zone occupancy. This feedback is first used to increase zone airflow in an attempt to satisfy space ventilation needs, as follows:

1. If a given zone’s carbon dioxide level exceeds maximum setpoint of 800 ppm (adjustable) for a period of 5 minutes (adjustable), zone airflow shall be increased in 10% increments (adjustable) every 5 minutes (adjustable) until space carbon dioxide levels remain below setpoint. Zone airflow shall not be increased over 80% (adjustable) max airflow to avoid over conditioning the space.
2. Once stable acceptable carbon dioxide levels are achieved, hold this level of airflow for no less than 60 minutes. At that time space airflow can be reduced in 10% increments every 5 minutes provided that space carbon dioxide levels remain acceptable.

H. Reports:

1. Configure a tabular report using real-time data with the following column headings: VAV TERMINAL DESCRIPTION, ZONE TEMPERATURE, EFFECTIVE Htg & Clg ZONE SETPOINTS, PRIMARY AIR FLOW SETPOINT, PRIMARY AIR FLOW, DAMPER POSITION (0 to 100%), REHEAT OUTPUT (0 to 100% heating), DISCHARGE AIR TEMPERATURE. At the top of the table list floor or area description, parent air handling unit designation, air handling unit static pressure and setpoint and air handler discharge air temperature and setpoint.

3.06 STEAM TO HW CONVERTER WITH VV PUMPS (M706)

A. General: BAS shall control the hot water systems and equipment and provide monitoring and diagnostic information for management purposes.

B. Heating Enable: Heating shall be always enabled, unless the system is manually disabled by the operator at the operator interface.

C. HW Pump Control:

1. Whenever the system is enabled, a minimum of one heating water pump shall run continuously.

2. BAS shall use a PID loop to maintain the differential pressure setpoint across the remote differential pressure sensors. The differential pressure setpoint shall initially be set at 15 psi (adj. as determined by the balance contractor). The output of the PID loop shall control the VFD's of all operating pumps at the same speed.
3. The output of this loop shall control the starting, stopping, and speed of the pumps as follows:
    a. On a PID output of greater than 95% for 5 min (adj.), the BAS shall start an additional pump. The new pump shall ramp to speed per adjustable acceleration rates.
    b. If more than one pump is running, on a PID output of less than 40% for 5 min (adj.), the BAS shall stop a pump.
4. BAS shall prove operation of each pump individually. Upon failure of a pump, the standby shall be started (if not already running) and an alarm shall be enunciated.
5. BAS shall monitor pump status and accumulate runtime of the pumps. The BAS shall rotate the lead and lag pumps as follows:
    a. Whenever a pump is started, the BAS shall start the pump with the least runtime.
    b. Whenever a pump is stopped, the BAS shall stop the pump with the highest runtime.

D. Heating Water Temperature Control: BAS shall reset the hot water supply temperature setpoint from 160°F (adj.) to 130°F (adj.) as the OA temperature rises from 20°F (adj.) to 60°F (adj.)
1. The BAS shall modulate the 1/3 and 2/3 steam valves to the Heat Exchanger in sequence via a PID loop to maintain the HW supply temperature setpoint.
2. The valves shall remain closed until pump status is proven.
3. Steam supply pressure to the Heat Exchanger shall be monitored by the BAS and enunciate an alarm if it falls below 5 psi (adj.)

3.07 FAN COIL UNITS (M711 & M712)

A. General: Control shall include scheduled occupancy with optimum preoccupancy, occupancy override, and reheat control as specified below. Schedule shall be the same as the parent AH.

B. Space Temperature Control: Three setpoints shall apply. Normal (72°F adj.)), setback heating (65°F (adj.)), and setback cooling (80°F). These three values shall be the only values changed by the operator to adjust space temperatures. All other deadbands, differentials, etc. shall be calculated in the program logic (unless another means is provided to prohibit overlap of the heating and cooling loops and ensure a dead band such as function block templates that restrict the setpoint input). During the normal periods, separate heating and cooling setpoints shall be calculated.
1. Normal space cooling setpoint: shall be the normal space temperature plus 2°F (adj.)
2. Normal space heating setpoint: shall be the normal space temperature minus 2°F (adj.)

C. Fan: Fan shall be enabled and run continuously during occupied mode. During unoccupied mode, fan shall be deenergized except as required to maintain setback temperature setpoints for both heating and cooling with a cycle differential of 3°f (adj.). Bas shall prove fan operation and use the status indication to accumulate runtime.

D. Valves: Heating and cooling control valves shall cycle as required to maintain space temperature setpoint for the associated mode (heating or cooling). Programming shall

be implemented to prevent overlap of the heating and cooling valves.

E. Dehumidification: If zone relative humidity rises above 58%, unit shall be enabled. Chilled water valve control for space temperature shall be overridden via high select if space humidity levels remain over 54% relative humidity, with chilled water valve modulating between 0% at 54% RH and 100% open at 58% RH. Reheat coil shall maintain space temperature per normal sequence of operation.

3.08 ELECTRIC UNIT HEATER (M708)

A. General: BAS shall enable the unit heater and provide monitoring and diagnostic information for management purposes.

B. Fan Control: BAS shall control the starting and stopping of the unit heater as follows:

1. Start/Stop: BAS shall command the operation of the unit heater and it shall run continuously when enabled per occupancy schedule.
2. Proof: BAS shall prove fan operation and use the status indication to accumulate runtime. Upon failure of an exhaust fan, the BAS shall enunciate an alarm.

C. Enable Heater: Unit heater shall be energized whenever space temperature falls below the active heating setpoint.

D. Disable Heater: Unit heater shall be deenergized whenever space temperature rises below the active heating setpoint deadband.

3.09 EXHAUST FANS F-B-1, F-B-2, & F-1-1 (M711)

A. General: BAS shall provide monitoring and diagnostic information for management purposes.

B. Fan Control:

1. Enable/Disabled: The fan shall be enabled manually and shall run continuously.
2. Proof: BAS shall monitor fan operation and use the status indication to accumulate runtime. Upon failure of the exhaust fan (loss of status at any time), the BAS shall enunciate an alarm.

3.10 EXHAUST FAN F-3-2 (M713)

A. General: BAS shall provide monitoring and diagnostic information for management purposes.

B. Fan Control:

1. Enable/Disabled: The fan shall be enabled when either AHU-B-1 or AHU-3-1 is energized.
2. Proof: BAS shall monitor fan operation and use the status indication to accumulate runtime. Upon failure of the exhaust fan (loss of status at any time), the BAS shall enunciate an alarm.

3.11 SUMP PUMP CONTROLLERS (M713)

A. General: Sump pumps should operate independently from BAS, under their own control.

B. Monitoring: BAS shall monitor sump pump general alarm contact.

END OF SECTION

SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Ducted fan coil units and accessories.
   2. High wall fan coil units

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:
   1. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of fan coil unit indicated.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which fan coil units will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
   6. Perimeter moldings.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.07 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.02 DUCTED FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price Industries.
2. Carrier Global Corporation.
3. Daikin Applied.
4. Greenheck Fan Corporation.
5. IEC (International Environmental Corporation); LSB Industries.
6. Nailor Industries Inc.
7. Titus; brand of Johnson Controls International plc, Global Products.
8. Trane Inc.

B. Insulation: 1-inch- thick, closed-cell insulation complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.

D. Chassis: stainless steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.

E. Filters: Minimum MERV-8 with 2" filter rack

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain. Coils shall have minimum 0.025" wall thickness. Casings shall be stainless steel. Provide 0.025" copper tubing. Coils shall be leak testing at 315 psig minimum. Coils shall have NPT connections

G. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
1. Motors: Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

H. Control devices and operational sequence are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

I. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.03 HIGH WALL FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price Industries.
2. Carrier Global Corporation.
3. Daikin Applied.
4. Greenheck Fan Corporation.
5. IEC (International Environmental Corporation); LSB Industries.
6. Nailor Industries Inc.
7. Titus; brand of Johnson Controls International plc, Global Products.
8. Trane Inc.

B. Description: system consisting of Wall mounted unit with fan, cooling coil and integrated controls.

C. General:
1. Unit shall be a factory assembled and tested chilled and hot water fan coil.
2. Shall be assembled with high quality.
3. Contained with the unit shall be all factory wiring, piping, associated controls and special accessories required prior to start up.

D. Unit Cabinet:
1. Composed of high impact polymers.
2. Shall be internally insulated to ensure quiet operation.

E. Fan Motors:
1. Shall be 120-1-50/60 VAC.
2. Fan motors shall be three speed, direct drive, and PSC type.
3. Totally enclosed.
4. Internal overload protected.
5. Unit shall contain a swing motor to modulate the discharge air.

F. Blower Wheels:
1. Blower wheels are dynamically balanced.

G. Water Coil:
1. Manufactured with water coils containing 0.025" copper tubing mechanically bonded to aluminum fins.
2. Maximum operating pressure is 150 psi.
3. Maximum inlet water temperature 160 F.

H. Drain Pan:
1. All drain pans shall be molded with high impact polymers.
2. The exterior of all drain pans shall be insulated with closed cell insulation to prevent condensation.
3. Pans shall contain flexible drain tubing that is accessible from the back of the unit.

I. Filters:
1. Unit shall contain washable filters.

J. Controls
1. Fan coils shall be factory wired and tested.
2. Controls shall include a circuit board, wireless infrared remote controller with wall bracket and wall mounted 24 volt thermostat.
3. Unit shall be capable of operating on any 24 volt control

K. Safeties:
1. Fan coil shall contain a non reusable fuse on the secondary voltage side of the transformer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches to 60 inches above finished floor.

E. Install new filters in each fan coil unit within two weeks after Final Acceptance.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Testing Agency: a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 23 82 39.13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. DDC: Direct digital control.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Indicate location and arrangement of piping valves and specialties.
   7. Indicate location and arrangement of integral controls.
   8. Wiring Diagrams: Power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm; a Mestek company.
   2. Berko; Marley Engineered Products.
   3. Carrier Global Corporation.
   4. Chromalox, Inc.
   5. INDEECO.
   6. Marley Engineered Products.
   7. QMark; Marley Engineered Products.
   8. Trane.
   9. USA Coil & Air.

2.02 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.03 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.04 COIL SECTION INSULATION

A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.
   1. Thickness: 1 inch.
   2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.05 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's custom paint, in color selected by Architect.
   1. Recessed Flanges: Steel, finished to match cabinet.
   2. Control Access Door: Key operated.
   3. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
   4. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

2.06 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.07 CONTROLS

A. Fan and Motor Board: Removable.
   1. Fan: Forward curved, high static, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
   3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93.11 "Sequence of Operations for HVAC DDC."

C. DDC Terminal Controller:
   1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   2. Unoccupied Period Override: Two hours (adj).
   3. Unit Supply-Air Fan Operations:
      a. Occupied Periods: Fan runs continuously.
      b. Unoccupied Periods: Fan cycles to maintain setback room temperature.

4. Heating-Coil Operations:
   a. Occupied Periods: Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and energize electric-resistance coil if room temperature falls below setback temperature.

5. Controller shall have volatile-memory backup.

D. Interface with DDC System for HVAC Requirements:
1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central DDC system for HVAC workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit-heater start, stop, and operating status.
   c. Data inquiry, including supply-air and room-air temperature.
   d. Occupied and unoccupied schedules.

E. Electrical Connection: Factory-wired motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 07 92 00 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Final Acceptance.

3.03 CONNECTIONS

A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."

B. Comply with safety requirements in UL 1995.

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.04 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 26 00 10 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Supplemental requirements applicable to Work specified in Division 26.

1.02 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:
1. 8PSJ or 8P8C: Miniature 8-position series jack, also called an 8-position 8-contact modular jack for some applications.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. CO/ALR: Copper-aluminum, revised.
17. CU or Cu: Copper.
18. CU-AL or AL-CU: Copper-aluminum.
19. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
20. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
21. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
22. dBm: Decibel absolute power with respect to 1 mW.
23. DC or dc: Direct current.
24. DCOA: Designated critical operations area.
25. DDC: Direct digital control (HVAC).
26. EGC: Equipment grounding conductor.
27. EMF: Electromotive force.
28. EMI: Electromagnetic interference.
29. EPM: Electrical preventive maintenance.
30. EPS: Emergency power supply.
31. EPSS: Emergency power supply system.
32. ESS: Energy storage system.
33. EV: Electric vehicle.
34. EVPE: Electric vehicle power export equipment.
35. EVSE: Electric vehicle supply equipment.
36. fc: Footcandle, a unit of illuminance equal to one lumen per square foot.
37. FLC: Full-load current.
38. ft: Foot.
39. GEC: Grounding electrode conductor.
40. GFCI: Ground-fault circuit interrupter.
41. GFPE: Ground-fault protection of equipment.
42. GND: Ground.
43. HACR: Heating, air conditioning, and refrigeration.

44. HDPE: High-density polyethylene.
45. HID: High-intensity discharge.
46. HP or hp: Horsepower.
47. HVAC: Heating, ventilating, and air conditioning.
48. Hz: Hertz.
49. IBT: Intersystem bonding termination.
50. inch: Inch. To avoid confusion, the abbreviation "in." is Not Applicable.
51. IP: Ingress protection rating (enclosures); Internet protocol (communications).
52. IR: Infrared.
53. IS: Intrinsically safe.
54. IT&R: Inspecting, testing, and repair.
55. ITE: Information technology equipment.
56. kAIC: Kiloampere interrupting capacity.
57. kcmil or MCM: One thousand circular mils.
58. kV: Kilovolt.
59. kVA: Kilovolt-ampere.
60. kVAr or kVAR: Kilovolt-ampere reactive.
61. kW: Kilowatt.
62. kWh: Kilowatt-hour.
63. LAN: Local area network.
64. lb: Pound (weight).
65. LCD: Liquid-crystal display.
66. LCDI: Leakage-current detector-interrupter.
67. LED: Light-emitting diode.
68. LNG: Liquefied natural gas.
69. LP-Gas: Liquefied petroleum gas.
70. LRC: Locked-rotor current.
71. MCC: Motor-control center.
72. MG set: Motor-generator set.
73. MLO: Main lugs only.
74. MVA: Megavolt-ampere.
75. mW: Milliwatt.
76. MW: Megawatt.
77. MWh: Megawatt-hour.
78. NC: Normally closed.
79. NiCd: Nickel cadmium.
80. NIU: Network interface unit.
81. NO: Normally open.
82. NPT: National (American) standard pipe taper.
83. OCPD: Overcurrent protective device.
84. ONT: Optical network terminal.
85. PC: Personal computer.
86. PCS: Power conversion system.
87. PCU: Power-conditioning unit.
88. PF or pf: Power factor.
89. PHEV: Plug-in hybrid electric vehicle.
90. PLC: Programmable logic controller.
91. PLFA: Power-limited fire alarm.
92. PoE: Power over Ethernet.
93. PV: Photovoltaic.
94. PVC: Polyvinyl chloride.
95. pW: Picowatt.
96. RFI: Radio-frequency interference (electrical); Request for interpretation (contract).
97. RMS or rms: Root-mean-square.
98. RPM or rpm: Revolutions per minute.
99. SCADA: Supervisory control and data acquisition.

100. SCR: Silicon-controlled rectifier.
101. SPD: Surge protective device.
102. sq.: Square.
103. SWD: Switching duty.
104. TCP/IP: Transmission control protocol/Internet protocol.
105. TEFC: Totally enclosed fan-cooled.
106. TR: Tamper resistant.
107. TVSS: Transient voltage surge suppressor.
108. UL: Underwriters Laboratories, Inc. (standards) or UL LLC (services).
109. UL CCN: UL Category Control Number.
110. UPS: Uninterruptible power supply.
111. USB: Universal serial bus.
112. UV: Ultraviolet.
113. V: Volt, unit of electromotive force.
114. V(ac): Volt, alternating current.
115. V(dc): Volt, direct current.
116. VA: Volt-ampere, unit of complex electrical power.
117. VAr: Volt-ampere reactive, unit of reactive electrical power.
118. VFC: Variable-frequency controller.
119. VOM: Volt-ohm-multimeter.
120. VPN: Virtual private network.
121. VRLA: Valve-regulated lead acid.
122. W: Watt, unit of real electrical power.
123. Wh: Watt-hour, unit of electrical energy usage.
124. WPT: Wireless power transfer.
125. WPTE: Wireless power transfer equipment.
126. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:
1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit.
7. EPEC-40: Schedule 40 electrical HDPE underground conduit.
8. EPEC-80: Schedule 80 electrical HDPE underground conduit.
9. EPEC-A: Type A electrical HDPE underground conduit.
10. EPEC-B: Type B electrical HDPE underground conduit.
11. ERMC: Electrical rigid metal conduit.
12. ERMC-A: Aluminum electrical rigid metal conduit.
13. ERMC-S: Steel electrical rigid metal conduit.
14. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
15. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
16. ERMC-SS: Stainless steel electrical rigid metal conduit.
17. FMC: Flexible metal conduit.
18. FMC-A: Aluminum flexible metal conduit.
19. FMC-S: Steel flexible metal conduit.
20. FMT: Steel flexible metallic tubing.
21. FNMC: Flexible nonmetallic conduit. See LFNC.
22. HDPE: See EPEC.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.

29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Cable Types:
1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: Moisture-, heat-, and oil-resistant thermoplastic cable (machine tool wiring).
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.

36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: Thermoset rubber, heat-resistant cable (high heat).
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:
1. Basic Impulse Insulation Level: Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
2. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
3. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
4. Designated Seismic System: A system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
5. Direct Buried: Installed underground without encasement in concrete or other protective material.

6. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
    f. Device Box: A box with provisions for mounting a wiring device directly to the box.
    g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
    h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
    i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
    j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
    k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
    l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
    m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
    n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
    o. Raised-Floor Box: A floor box intended for use in raised floors.
    p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
    q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
    r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
    s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
    t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
7. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
8. Essential Electrical Systems: Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal

power sources, and also to minimize disruption within the internal wiring system. (healthcare facilities)

9. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
10. Jacket: A continuous nonmetallic outer covering for conductors or cables.
11. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
12. Miniature 8-Position Series Jack (8PSJ): Also called an 8-position 8-contact (8P8C) modular jack. An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Shape and dimensions are specified by TIA-1096.
    a. Caution: An 8PSJ is not the same thing as an FCC "registered jack" RJ45S, now called a miniature 8-position keyed jack (8PKJ). Ethernet cable plugs do not have rejection keys. Many manufacturers and suppliers incorrectly use "RJ45" as a generic term to describe any 8-position series plug or jack whether it has a rejection key or not.
13. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
14. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
15. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
16. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
17. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
18. Sheath: A continuous metallic covering for conductors or cables.
19. UL Category Control Number: An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
20. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage: Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
    e. Medium Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
    f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

1.03 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
   1. Notify Owner no fewer than 14 days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Owner's written permission.
   3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
      a. Emergency lighting.
      b. Elevators.
      c. Fire-alarm systems.

B. Arrange to provide temporary electrical service or power in accordance with requirements specified in Division 01.

1.04 SEQUENCING

A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.05 ACTION SUBMITTALS

A. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 01 31 00 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Elevation, size, and route of cable trays.
   2. Relationships between components and adjacent structural, electrical, and mechanical elements.
   3. Vertical and horizontal offsets and transitions.
   4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
   5. Elevation of ceilings and size of ceiling tiles.
   6. Locations of access panels on ceilings.
   7. Locations where cable tray crosses or parallels sprinkler piping.
   8. Locations where cable tray crosses plumbing piping.
   9. Locations where cable tray crosses or parallels ductwork.
   10. Locations of access panels on ductwork.
   11. Locations where cable tray crosses conduit.
   12. Items blocking access around cable trays, including the following:
      a. Light fixtures.
      b. Speakers.
      c. Fire-alarm devices.
      d. Power outlets.
      e. Wall-mounted equipment.
      f. Equipment racks.
      g. Furniture.
      h. Door swings.
      i. Building features.
   13. Indicate clear dimension between cable tray and walls or obstructions that are closer than 10 ft.
   14. Highlight locations where cable tray is greater than 3 ft above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.

B. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

C. Coordination Drawings for Large Equipment Indoor Installations:
   1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
   2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
      b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
      c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
   3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, busways.
      b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
      c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.

D. Coordination Drawings for Large Equipment Outdoor Installations:
   1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
      a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
      b. Indicate clear dimensions for fence gates and wall openings.
      c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
      d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
      e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, busways,
      f. Dimensioned working clearances and dedicated areas around electrical equipment.

E. Coordination Drawings for Duct Banks: Signed and sealed by qualified professional engineer.
   1. Show duct profiles and coordination with other utilities and underground structures.
   2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. Include the following information:
      a. Manufacturer's operating specifications.
      b. User's guides for software and hardware.
      c. Schedule of maintenance material items recommended to be stored at Project site.
      d. Detailed instructions covering operation under both normal and abnormal conditions.
      e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
      f. List of load-current and overload-relay heaters with related motor nameplate data.

g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.

B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation in Facility EPM Program Binders, including the following:
1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls include the following:
a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

1.07 QUALIFICATIONS

A. Electrical Power Monitoring Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired certified Installer credentials issued by manufacturer prior to starting installation.

B. Lightning Protection System Installers: Installer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," and able to present unexpired UL-Listed Installer, UL Category Control Number OWAY, credentials or unexpired LPI Master Installer credentials prior to starting installation.

1.08 FIELD CONDITIONS

A. Service Conditions for Electrical Power Equipment: specified electrical power equipment must be suitable for operation under service conditions specified as usual service conditions in applicable NEMA PB series, IEEE C37 series, and IEEE C57 series standards, except for the following:
1. Exposure to significant solar radiation.
2. Exposure to fumes, vapors, or dust.
3. Exposure to explosive environments.
4. Ambient temperature not exceeding 104 deg F.
5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
6. Unusual transportation or storage conditions.
7. Unusual grounding resistance conditions.
8. Unusual space limitations.

1.09 EXISTING CONDITIONS

A. Existing Circuits:
1. All existing circuits which are re-used for connection to new or replacement equipment shall be thoroughly inspected for size, condition, and suitability for re-use.

B. Remediation of Hazardous Materials:
1. Existing facility/building shall be investigated through appropriate testing and/or inspection methods to confirm the presence of and hazardous material that may exist in the electrical system components. If it is determined that remediation is required, then a plan must be implemented rendering the facility free of hazards. This includes but is not limited to Asbestos, Lead, and PCB’s.

C. Abandonment of existing electric system components:
1. Abandoned conduit/boxes shall have all electrical wiring removed completely and not just made "safe". Conduit/boxes shall be removed where practical without creating additional demolition/restitution work for other trades. All existing power supply wiring or cabling

associated with equipment demolished or removed as part of the project scope shall be completely removed back to supply distribution panel and circuit breakers relabeled as "SPARE" or with the new circuit title and left in the OFF position.

2. Abandoned existing conduits concealed within floors and walls shall be cut flush with the surface and grouted over. Openings in fire rated assemblies shall be properly fire stopped in accordance with the barrier rating following removal or wiring and conduit.

PART 2 - PRODUCTS

2.01 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:
   1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
   2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
   3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

B. Materials and equipment shall be third party listed by an approved and accredited agency. Third party agencies shall be among those accredited by the North Carolina Building Code Council (NCBCC) to label electrical and mechanical equipment.

2.02 FACILITY ELECTRICAL PREVENTIVE MAINTENANCE (EPM) PROGRAM BINDERS

A. Description: Set of binders containing operation and maintenance data for facility's electrical equipment that was compiled during analysis of installed electrical Work for Facility EPM Program development.

B. Applicable Standards:
   1. Regulatory Requirements: Comply with recommendations in NFPA 70B.
   2. General Characteristics:
      a. Volume 1 - Introduction:
         1) Summarize how Facility EPM Program Analysis was performed, how data were collected, and how volumes are organized.
         2) Describe Facility EPM Program and provide recommended policies and procedures for implementing the program and keeping it current.
         3) Provide place for Owner to identify contact information for employees responsible for implementing and maintaining Facility EPM Program.
      b. Volume 2 - Facility Safety, Hazards Awareness, and Emergency Procedures:
         1) Include training requirements for employees and contractors.
         2) Include list of known facility hazards impacting IT&R activities.
         3) Include approval and permitting procedures for IT&R activities.
         4) Include incident emergency response procedures.
         5) Include emergency shutdown procedures.
         6) Include electrical disaster recovery procedures.
      c. Volume 4 - Facility Diagrams and Schedules:
         1) Include single-line diagrams.
         2) Include grounding and bonding diagrams.
         3) Include essential wiring diagrams.
         4) Include system automation diagrams (SCADA, BMS, lighting, HVAC, etc.).
         5) Include records of switchgear, switchboard, and panelboard schedules.
         6) Include time-current curves for overcurrent protective devices.

7) Include list of load-current and overload-relay heaters with related motor nameplate data.

d. Volume 5 - Inventory of Facility Equipment Using Electrical Power:
   1) Include simplified floor plans showing equipment locations.
   2) Identify critical equipment (electrical or otherwise).
   3) Include identifying designations and nameplate data.
   4) Include warranty and maintenance contract information.

e. Volume 6 - Inventory of Facility Tools, Supplies, and Personnel Protective Equipment:
   1) Include schedules of maintenance material items recommended to be stored at facility.
   2) Include list of lamp types and photoelectric relays used in facility with ANSI and manufacturers' codes.
   3) Include calibration and servicing data for each item.

f. Volume 7 - Inspection, Testing, and Repair (IT&R) Plan:
   1) Include tables showing frequency of activities for each item.
   2) Include annual schedule with activities mapped to specific days of the year.
   3) Include exterior pole inspection and repair procedures.

g. Volume 10 - Spare Parts List:
   1) Include list of all parts required to perform IT&R procedures.
   2) Identify quantities of which parts are recommended to be stored on-site.
   3) Include source contact information and budget cost for each item.

h. Volume 11 - Construction Project Closeout Record Documentation:
   1) Include records of power system studies and photometric studies.
   2) Include records of risk assessment studies.
   3) Include records of electrical system startup and commissioning activities.
   4) Include records of baseline inspections and tests.
   5) Include records of baseline infrared photographs with normal light photographs showing the location, direction, angle, and conditions necessary for reproducing each infrared photograph.
   6) Include records of baseline settings for adjustable equipment and devices.

PART 3 - EXECUTION

3.01 DEVELOPMENT OF FACILITY EPM PROGRAM

A. Facility EPM Program must be developed by qualified EPM specialist.

B. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.
   1. Renovation Projects:
      a. Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
      b. Obtain copies of existing operation and maintenance data and existing Facility EPM Program information from Owner.
      c. Facility EPM Program analysis should identify existing equipment that does not have available operation and maintenance data, and should explain the Owner's risks because this equipment is not included in Facility EPM Program.
      d. Data for existing equipment outside scope of Project may be inserted in Facility EPM Program Binders without analysis.
      e. Data for existing equipment impacted by scope of Project should be analyzed and documented similar to Project's new equipment data as much as possible.

C. Compile operation and maintenance data from Facility EPM Program analysis and submit Facility EPM Program Binders.

3.02 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.03 SHORT CIRCUIT AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Protective devices shall be set and calibrated as recommended by the Engineer’s final fault current and coordination study.

B. Provide arc flash hazard labels with information provided by the Engineer’s final arc flash evaluation study and apply labels to the equipment.

C. Furnish all field data as required by the power system studies. The Engineer performing the short-circuit and coordination studies will furnish the Contractor with a listing of required data. The Contractor shall expedite collection of the data to eliminate unnecessary delays and ensure completion of the studies as required for final approval of the distribution equipment shop drawings and /or prior to the release of the equipment for manufacturing.

3.04 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:
1. Will engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified low-voltage electrical testing and inspecting agency to administer and perform tests and inspections.

B. Administrant for Field Tests and Inspections of Lighting Installations:
1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
2. Administer and perform tests and inspections.

C. The electrical contractor shall notify the office of the State Electrical Inspector in the Construction Administration section of the State Construction Office to schedule required inspections including rough-in, above ceiling, and final inspections. Inspections shall only be scheduled Monday through Friday, unless specifically approved otherwise by the SCO Field Electrical Inspector.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration:
1. With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel how to operate the following systems and equipment:
   a. Lighting control systems specified in Section 26 09 23 "Lighting Control Devices."
   b. Lighting control systems specified in Section 26 09 43.16 "Addressable Luminaire Lighting Controls."
   c. Electronic metering and billing software specified in Section 26 27 13 "Electricity Metering."
2. Provide video recordings of demonstrations to Owner.

B. Training:
1. With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:
   a. How to implement Facility EPM Program.
   b. How to operate normal and emergency electrical systems, including justifications for, and limitations of, protective device settings recommended in coordination
   c. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in arc-flash hazard analysis report.

d. How to adjust, operate, and maintain devices specified in Section 26 09 23 " Lighting Control Devices."
e. How to adjust, operate, and maintain hardware and software specified in Section 26 09 43.16 "Addressable Luminaire Lighting Controls."
f. How to adjust, operate, and maintain equipment specified in Section 23 29 23 "Variable-Frequency Motor Controllers."

2. Provide video recordings of training sessions to Owner.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Copper building wire.
2. Fire-alarm wire and cable.
3. Connectors and splices.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 27 13 13 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
3. Section 27 15 13 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.02 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, undefined:
1. Cerro Wire LLC.
2. Encore Wire Corporation.
3. General Cable; Prysmian Group North America.
4. Okonite Company (The).
5. Southwire Company.

C. Standards:
1. Listed and labeled by an NCBCC approved third party testing agency accredited by the NCBCC.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 ASTM B496 for stranded conductors.

E. Conductor Insulation:
1. Dual rated Type THHN/THWN: Comply with UL 83.

2.02 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Wire & Cable Inc.
2. CommScope, Inc.
3. Comtran Corporation.
4. Genesis Cable Products; Honeywell International, Inc.
5. Vent (PYROTENAX).
6. Prysmian Cables and Systems; Prysmian Group North America.
7. Radix Wire.
8. Rockbestos-Suprenant Cable Corp.
9. Superior Essex Inc.

10. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
1. Lead Content: Less than 300 parts per million.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No 18 AWG.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
1. Low-Voltage Circuits: No. 18 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.03 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers:

Joints in solid conductors shall be spliced using the following:
1. 3M Electrical Products.
2. T&B Connectors.
3. Ideal Industries, Inc.

C. "Sta-Kon", "Piggy", or other permanent type crimp connectors shall be used for #10 AWG and smaller conductors.

D. Joints in stranded conductors shall be spliced by approved mechanical connectors that are insulated with gum rubber tape and insulating tape. Permanent compression connectors for splices and taps, provided with UL-approved insulating covers, may be used instead of mechanical connectors plus tape. Power Distribution Blocks may be used where listed for the enclosure size and available fault current.

E. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; Class B stranded for No. 8 AWG and larger.

B. Branch Circuits :Copper. Solid for No. 10 AWG and smaller; Class B stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Dual Type THHN/THWN, single conductors in raceway.

B. Exposed Feeders: Dual Type THHN/THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Dual Type THHN/THWN, single conductors in raceway.

D. Exposed Branch Circuits: Dual Type THHN/THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Dual Type THHN/THWN, single conductors in raceway.

3.03 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

G. Power and lighting circuits' minimum conductor size shall be #12 AWG, and maximum conductor size allowed shall be 500 Kcmil.

H. Where the conductor length from the panel to the first outlet on a 277-volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.

I. Where the conductor length from the panel to the first outlet on a 120-volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG.

3.04 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 27 05 29 "Hangers and Supports for Communications Systems."
   1. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
      a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
   3. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in device terminal blocks or on terminal blocks in cabinets. where circuit connections are made.

E. Color-Coding: Shall be performed in accordance with electrical specification section 26 05 53 "Identification for electrical systems".

F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.05 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Connections made with terminal strips shall only be made at device terminal blocks or on terminal blocks in cabinets.

C. Comply with requirements in Section 28 46 21.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.06 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.08 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.09 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.
      e. Inspect cable jacket and condition.
      f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
      g. Continuity test on each conductor and cable.
      h. Uniform resistance of parallel conductors.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Ground bonding common with lightning protection system.

B. Related Requirements:
   1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.02 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. *Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment*

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B3.
   2. Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inch in cross section, with 9/32 inch holes spaced 1-1/8 inch apart. Stand-off insulators for mounting must comply with UL 891 for use in switchboards, 600 V and must be Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

A. Listed and labeled by an NRTL for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Exothermic Welds: Exothermic-welding kits of types recommend by kit manufacturer for ground rod and conductor.

I. Lay-in Lug Connector: Compression type, non-reversible, copper rated for direct burial.

J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

K. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

L. Straps: Solid copper, copper lugs. Rated for 600 A.

M. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

N. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

O. Water Pipe Clamps:
1. Mechanical type, two pieces with zinc-plated bolts.
    a. Material: Tin-plated aluminum.
    b. Listed for direct burial.
2. U-bolt type listed for indicated application.

2.04 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 ft.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.
1. Bury at least 30 inch below grade.

C. Grounding Conductors: Green-colored insulation.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
2. Identify each grounding electrode that is connected to a common ground bus. The common ground bus shall not be less than 2" high by 1/4" thick.

F. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

G. The raceway system shall not be relied on for equipment ground continuity. A green equipment grounding conductor shall be run in all raceways except for telecommunications, data, audio systems, and low voltage raceways for fire alarm systems.

H. Boxes with concentric, eccentric, or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC Table 250-122 and lugged to the box.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors must be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

B. The electrical service shall be grounded by three (3) means, when available:

1. To the metallic cold-water pipe, as per NEC article 250-52.
2. To the steel frame of the building, provided the building frame is effectively grounded. In new construction, effectively ground and bond steel building frame.
3. To ground rod(s). Ground rods shall be 10 feet long and 3/4-inch in diameter and shall be of copper-clad steel construction. All ground connections shall be accessible. Provide a minimum of one test well at one driven ground rod.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.04 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.05 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.
   1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Bond each aboveground portion of ident system downstream from equipment shutoff valve.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft. apart.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inch from building's foundation.

I. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

J. Grounding electrode conductors #4 AWG and larger shall be installed in a raceway system.

K. All building interior portions of grounding electrode conductors less than 6 feet above finished floor shall be protected against physical damage by routing in raceway except for final terminations to equipment where concealed.

3.06 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceed the following values:
    1. Power and Lighting Equipment or System: 25 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Support, anchorage, and attachment components.
   2. Fabricated metal equipment support assemblies.

B. Related Requirements:
   1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Products Division.
      b. Allied Tube & Conduit; Atkore International.
      c. B-line; Eaton, Electrical Sector.
      d. Unistrut; Atkore International.
   2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   3. Material for Channel, Fittings, and Accessories: Galvanized steel.
   4. Channel Width: Selected for applicable load criteria.
   5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron. Plugs must allow for cables to be supported through the interior and not along the exterior

D. Cable Support Device: Kellem type grips made of galvanized steel, designed for types and sizes of cable to be supported.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   2. Toggle Bolts: All steel springhead type.
   3. Hanger Rods: Threaded steel.

F. Powder actuated fasteners are not allowed.

PART 3 - EXECUTION

3.01 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA NEIS 101
   2. NECA NEIS 102.
   3. NECA NEIS 105.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

D. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 3/8 inch in diameter.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps.

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT and ERMC may be supported by openings through structure members, in accordance with NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

F. Conduits installed on the interior of exterior walls shall be spaced off the wall surface a minimum of ¼ inch using "clamp-backs" or struts.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup:
1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
2. Comply with requirements in Section 09 91 13 "Exterior Painting" Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Metal raceways and fittings.
2. Nonmetallic raceways and fittings.
3. Fittings for conduit, tubing, and cable.
4. Wireways and auxiliary gutters.
5. Surface metal raceways and fittings.
6. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.
7. Cover plates for device boxes

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
3. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
4. Section 27 05 28 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
5. Section 27 05 43 "Underground Pathways and Structures for Communication Systems" for exterior communications duct banks, manholes, and underground utility construction.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:
1. Floor boxes.

PART 2 - PRODUCTS

2.01 TYPE EMT-S RACEWAYS AND ELBOWS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 797 and UL Category Control Number FJMX.

B. Steel Electrical Metal Tubing (EMT-S) and Elbows:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; Atkore International.
b. Calconduit; Atkore International.
c. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
d. Western Tube; Zekelman Industries.
e. Wheatland Tube; Zekelman Industries.

2. Material: Steel.
3. Options:

a. Exterior Coating: Zinc.

b. Interior Coating: Zinc with organic top coating.
c. Minimum Trade Size:

1) Interior wiring system: Metric designator 21 (trade size 3/4)
2) Exterior wiring system: trade size 1"..

2.02 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 6 and UL Category Control Number DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. Manufacturers: Subject to compliance with requirements, undefined:

a. Allied Tube & Conduit; Atkore International.
b. Calconduit; Atkore International.
c. Crouse-Hinds; brand of Eaton, Electrical Sector.
d. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
e. Western Tube; Zekelman Industries.
f. Wheatland Tube; Zekelman Industries.

2. Exterior Coating: Zinc.
3. Options:

a. Interior Coating: Zinc with organic top coating.
b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
c. Colors: As indicated on Drawings.

2.03 TYPE FMC-S RACEWAYS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 1 and UL Category Control Number DXUZ.

B. Steel Flexible Metal Conduit (FMC-S):
1. Manufacturers: Subject to compliance with requirements, undefined:

1) ABB, Electrification Business.
2) Electri-Flex Company.
3) International Metal Hose Co.
4) Penn Aluminum Conduit & EMT

2. Material: Steel.
3. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
b. Exception:½" flexible metal conduit not exceeding six feet may be used for fixture and small equipment drops.

2.04 TYPE LFMC RACEWAYS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the

NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

2. General Characteristics: UL 360 and UL Category Control Number DXHR.

B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, undefined:

   a. ABB, Electrification Business.
   b. Anaconda Sealtite; Anamet Electrical, Inc.
   c. International Metal Hose Co.

2. Material: Steel.
3. Options:

   a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
   b. Colors: As indicated on Drawings.

4. Material: Stainless steel.
5. Options:

   a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.05 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 651 and UL Category Control Number DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, undefined:

   a. ABB, Electrification Business.
   b. Calconduit; Atkore International.
   c. JM Eagle; J-M Manufacturing Co., Inc.
   d. NAPCO; Westlake Chemical Corp.
   e. Opti-Com Manufacturing Network, Inc (OMNI).

2. Dimensional Specifications: Schedule 40.
3. Options:

   a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
   b. Markings: For use with maximum 90 deg C wire.

2.06 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

B. Fittings for Type ERMC, Type PVC, Raceways:

1. Manufacturers: Subject to compliance with requirements, undefined:

   a. ABB, Electrification Business.
   b. Crouse-Hinds; brand of Eaton, Electrical Sector.
   c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.

d. Konkore Fittings; Atkore International.
e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
g. Southwire Company, LLC.

2. General Characteristics: UL 514B and UL Category Control Number DWTT.
3. Options:

a. Material: Steel.
b. Coupling Method: Compression coupling.
c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

C. Fittings for Type EMT Raceways:
1. Manufacturers: Subject to compliance with requirements, undefined:

a. ABB, Electrification Business.
b. Allied Tube & Conduit; Atkore International.
c. Calconduit; Atkore International.
d. Crouse-Hinds; brand of Eaton, Electrical Sector.
e. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
f. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Southwire Company, LLCGeneral Characteristics: UL 514B and UL Category Control Number FKAV.

3. Options:

a. Material: Steel.
b. Coupling Method: Compression coupling.
c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

D. Fittings for Type FMC Raceways:
1. Manufacturers: Subject to compliance with requirements, undefined:

a. American Fittings Corp. (AMFICO).
b. Liquid Tight Connector Co.
c. Southwire Company, LLC.

2. General Characteristics: UL 514B and UL Category Control Number ILNR.

E. Fittings for Type LFMC Raceways:
1. Manufacturers: Subject to compliance with requirements, undefined:

a. Liquid Tight Connector Co.

2. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.07 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.

2.08 SURFACE METAL RACEWAYS AND FITTINGS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 5 and UL Category Control Number RJBT.

B. Surface Metal Raceways and Fittings with Metal Covers:
1. Manufacturers: Subject to compliance with requirements, undefined:

a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
b. MonoSystems, Inc.
c. Wiremold; Legrand North America, LLC.

2. Options:

a. Aluminum base with snap-on covers.
b. Manufacturer's standard enamel finish in color selected by Architect.
c. Wiring Channels: Dual. Multiple channels must be capable of housing a standard 20 to 30 A NEMA device flush within the raceway.

2.09 WIREWAYS AND AUXILIARY GUTTERS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 870 and UL Category Control Number ZOYX.

B. Metal Wireways and Auxiliary Gutters:
1. Additional Characteristics:

a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
b. Finish: Manufacturer's standard enamel finish.

2. Options:

a. Degree of Protection: Type 1 unless otherwise indicated.
b. Wireway Covers: Screw-cover type unless otherwise indicated.

2.10 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:
1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with

provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

2. Options:

    a. Material: Sheet steel.
    b. Sheet Metal Depth: Minimum 2.5 inch.
    c. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb.
    d. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

C. Metallic Conduit Bodies:
1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

D. Metallic Device Boxes:
1. Description: Box with provisions for mounting wiring device directly to box.
2. Options:

    a. Material: Sheet steel.
    b. Sheet Metal Depth: minimum 2.5 inch.

E. Metallic Extension Rings:
1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

F. Metallic Floor Boxes and Floor Box Covers:
1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. FSR Inc.
    b. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    d. Pass & Seymour; Legrand North America, LLC.
    e. Wiremold; Legrand North America, LLC.

G. Metallic Raised-Floor Boxes and Floor Box Covers:
1. Description: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Wiremold; Legrand North America, LLC.

H. Metallic Concrete Boxes and Covers:
1. Description: Box intended for use in poured concrete.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Electrification Business.
    b. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    c. Wiremold; Legrand North America, LLC.

2.11 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 1773 and UL Category Control Number XCKT.

C. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Hoffman; brand of nVent Electrical plc.
d. Square D; Schneider Electric USA.

2. Additional Characteristics: Listed and labeled for installation on line side of service equipment.

D. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Hoffman; brand of nVent Electrical plc.
d. Square D; Schneider Electric USA.

2. Additional Characteristics: Listed and labeled for installation on load side of service equipment.

2.12 CABINETS, CUTOUT BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics:

a. Non-Environmental Characteristics: UL 50.
b. Environmental Characteristics: UL 50E.

B. Indoor Sheet Metal Cabinets:
1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Additional Characteristics: UL Category Control Number CYIV.
3. Options:

a. Degree of Protection: Type 1.

C. Indoor Sheet Metal Junction and Pull Boxes:
1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Additional Characteristics: UL Category Control Number BGUZ.
3. Options:

a. Degree of Protection: Type 1.

D. Outdoor Sheet Metal Junction and Pull Boxes:
1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Additional Characteristics: UL Category Control Number BGUZ.
3. Options:

a. Degree of Protection: Type 3R.

E. Outdoor Cast-Metal Junction and Pull Boxes:
1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Additional Characteristics: UL Category Control Number BGUZ.
3. Options:

a. Degree of Protection: Type 3R.

2.13 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics:

a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Metallic Cover Plates for Device Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.
b. Crouse-Hinds; brand of Eaton, Electrical Sector.
c. EGS; Emerson Electric Co., Automation Solutions, Appleton Group.
d. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
e. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
f. Leviton Manufacturing Co., Inc.
g. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
h. Pass & Seymour; Legrand North America, LLC.
i. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
j. Wiremold; Legrand North America, LLC.

2. Options:

a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
b. Wallplate Material: 0.032 inch thick Type 302/304 non-magnetic stainless steel with brushed finish.

2.14 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics:

    a. Reference Standards:

        1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
        2) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

    b. Mounts to box using fasteners different from wiring device.

B. Extra-Duty, While-in-Use Hoods for Outlet Boxes:
1. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
2. Options:

    a. Provides clear, weatherproof, "while-in-use" cover.
    b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.01 SELECTION OF RACEWAYS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:
1. Exposed and Subject to Physical Damage: ERMC.

    a. Locations less than 2.5 m (8 ft) above finished floor.

2. Exposed and Not Subject to Physical Damage: ERMC.
3. Concealed Aboveground: ERMC.
4. Direct Buried: PVC-40.
5. Concrete Encased in Trench: PVC-40.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

C. Indoors:
1. Exposed in mechanical and electrical rooms below 8’ 0” above the finished floor: ERMC.
2. Exposed in mechanical and electrical rooms above 8’ 0” above the finished floor: EMT.
3. Exposed in unfinished areas: EMT.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERMC and IMC: Provide threaded type fittings unless otherwise indicated.

3.02 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:
1. Outdoors:

a. Type 3R unless otherwise indicated.
b. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Locations Exposed to Spraying Oil or Coolants: Type 13.

3.03 INSTALLATION OF RACEWAYS

A. Installation Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
3. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
4. Comply with NECA NEIS 101 for installation of steel raceways.
5. Comply with NECA NEIS 102 for installation of aluminum raceways.
6. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
7. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
1. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
8. Raceway Terminations at Locations Subject to Moisture or Vibration:

a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

B. General Requirements for Installation of Raceways:
1. Raceways serving luminaires above inaccessible ceilings shall transition from junction box (located in accessible location) to 90-degree EMT bend with a coupling to flexible metal conduit or luminaire whip.
2. Complete raceway installation before starting conductor installation.
3. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
4. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inch of changes in direction.
5. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
6. Conceal conduit within finished walls, ceilings, unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
7. Support conduit within 12 inch of enclosures to which attached.
8. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.

9. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where an underground service raceway enters a building or structure.
    c. Conduit extending from interior to exterior of building.
    d. Conduit extending into pressurized duct and equipment.
    e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
    f. Where otherwise required by NFPA 70.

10. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
11. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
12. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
13. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
14. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
15. Where underground raceways are required to turn up to cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of rigid steel for the last two feet minimum.
16. Where grounding electrode conductors are required to be installed in raceway, and that raceway is metallic, the conduit must be bonded to the grounding electrode conductor on both ends.
17. Raceways within existing exterior walls shall be installed recessed and in accordance with Architectural details. Refer to Architectural Drawings for additional information.

C. Requirements for Installation of Specific Raceway Types:
    1. Types ERMC:

        a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

    2. Types FMC, LFMC:

        a. Comply with NEMA RV 3. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

    3. Type PVC:

        a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
        b. Comply with manufacturer's written instructions for solvent welding and fittings.

D. Raceways Embedded in Slabs:

1. Raceways shall not be installed in slabs unless serving floor boxes per UNC requirements.
2. Run raceways larger than metric designator 27 (trade size 1) below concrete slab. Run raceways larger than metric designator 27 (trade size 1) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place raceway close to slab support. Secure raceways to reinforcement at maximum 10 ft intervals.
3. Arrange raceways to cross building expansion joints with expansion fittings at right angles to the joint.
4. Arrange raceways to ensure that each is surrounded by a minimum of 2 inch of concrete without voids.
5. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

E. Stub-ups to Above Recessed Ceilings:
1. Provide EMT, or ERMC for raceways.
2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

F. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
1. ERMC-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
2. EMT: Provide compression steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

G. Expansion-Joint Fittings:
1. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

H. Raceways Penetrating Rooms or Walls with Acoustical Requirements:
1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

3.04 INSTALLATION OF BOXES AND ENCLOSURES

A. Stamped style sheet metal outlet boxes shall only be installed in finished spaces where they are concealed or exposed in unfinished spaces.

B. Junction boxes serving luminaires mounted above inaccessible ceilings shall be located above an accessible ceiling or an access panel provided in a location coordinated with the Architect prior to installation.

C. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

D. Junction and pull boxes above suspended ceiling shall be located between (3) and (36) inches above the suspended ceiling for accessibility. Removal of duct or ceiling grid shall not be required to access pull or junction boxes.

E. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

F. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

G. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

H. Locate boxes so that cover or plate will not span different building finishes.

I. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.

J. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.

K. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.

L. Set metal floor boxes level and flush with finished floor surface.

M. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.

O. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
   1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
   2. Provide gaskets for wallplates and covers.

3.05 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.06 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.07 CLEANING

A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Type ERMC-S raceways, elbows, couplings, and nipples.
2. Type PVC raceways and fittings.
3. Fittings for conduit, tubing, and cable.
4. Solvent cements.
5. Duct accessories.
6. Handholes and boxes for exterior underground wiring.
7. Manholes for exterior underground wiring.
8. Utility structure accessories.
9. Duct sealing.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

1.02 DEFINITIONS

A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.

B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.

C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.

D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.03 ACTION SUBMITTALS

A. Product Data:
1. Duct-bank materials, including spacers and miscellaneous components.
2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes.
4. Underground-line warning tape.

B. Shop Drawings:
1. Precast or Factory-Fabricated Concrete Structures:

a. Include plans, elevations, sections, and details, including attachments to other Work.
b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include grounding details.
f. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
g. Include joint details.

PART 2 - PRODUCTS

2.01 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; Atkore International.
b. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
c. Wheatland Tube; Zekelman Industries.

2. Exterior Coating: Zinc.
3. Options:

a. Interior Coating: Zinc with organic top coating.
b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.02 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Products Division.
b. Opti-Com Manufacturing Network, Inc (OMNI).
c. Topaz Lighting & Electric.

2. Dimensional Specifications: Schedule 40.
3. Options:

a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
b. Markings: For use with maximum 90 deg C wire.

2.03 SOLVENT CEMENTS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

2.04 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ABB, Electrification Products Division.
      b. Allied Tube & Conduit; Atkore International.
      c. Cantex Inc.

B. Underground-Line Warning Tape: In accordance with Section 26 05 53 "Identification for Electrical Systems."

2.05 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
   2. General Characteristics:
      a. ASTM C858 for design and manufacturing processes.
      b. SCTE 77.

B. Precast Concrete Handholes and Boxes :
   1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.
   2. Manufacturers: Subject to compliance with requirements, undefined:
      a. Christy Concrete Products.
      b. Oldcastle Infrastructure Inc.; CRH Americas.
      c. Utility Concrete Products, LLC.
   3. Configuration: Units must be designed for flush burial and have integral closed bottom unless otherwise indicated.
   4. Frame and Cover:
      a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
      b. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
      c. Cover Legend: Molded lettering, as indicated for each service.
   5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
      a. Extension must provide increased depth of 12 inch.
      b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
   6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
   7. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations.
      a. Splayed location.

b. Knockout panels must be located no less than 6 inch from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
d. Knockout panels must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
e. Knockout panels must be 1-1/2 to 2 inch thick.

8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size: Match fittings to duct to be terminated.
b. Fittings must align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.

9. Handholes 12 inch wide by 24 inch long and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:
1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. NewBasis.
b. Oldcastle Infrastructure Inc.; CRH Americas.
c. Quazite; Hubbell Incorporated, Power Systems.

3. Configuration: Units must be designed for flush burial and have integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.

a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
b. Cover Legend: Molded lettering, as indicated for each service.

5. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
8. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.
9. Options:

a. Color: Gray.

D. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover:
   1. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Christy Concrete Products.
      b. NewBasis.
      c. Oldcastle Infrastructure Inc.; CRH Americas.
      d. Quazite; Hubbell Incorporated, Power Systems.

   3. Configuration: Units must be designed for flush burial and have integral closed bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

      a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
      b. Cover Legend: Molded lettering, as indicated for each service.

   5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
   7. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.
   8. Options:

      a. Color: Gray.

E. Fiberglass Handholes and Boxes:
   1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Christy Concrete Products.
      b. Oldcastle Infrastructure Inc.; CRH Americas.
      c. Quazite; Hubbell Incorporated, Power Systems.

   3. Configuration: Units must be designed for flush burial and have integral closed bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

      a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
      b. Cover Legend: Molded lettering, as indicated for each service.

   5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
   7. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.
   8. Options:

a. Color: Gray.

2.06 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
2. General Characteristics:

a. ASTM C858 for design and manufacturing processes.
b. SCTE 77.

B. Precast Concrete Manholes:
1. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
2. Manufacturers: Subject to compliance with requirements, undefined:

a. Christy Concrete Products.
b. Oldcastle Infrastructure Inc.; CRH Americas.
c. Utility Concrete Products, LLC.
d. Utility Vault Co.

3. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations.

a. Splayed location.
b. Knockout panels must be located no less than 6 inch from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
d. Knockout panel must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
e. Knockout panels must be 1-1/2 to 2 inch thick.

4. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size: Match fittings to duct to be terminated.
b. Fittings must align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.

5. Ground Rod Sleeve: Provide 3 inch PVC sleeve in manhole floors 2 inch from wall adjacent to, but not underneath, duct entering structure.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
7. Source Quality Control: Test and inspect in accordance with ASTM C1037.

2.07 DUCT SEALING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products.
2. Oldcastle Infrastructure Inc.; CRH Americas.
3. Quazite; Hubbell Incorporated, Power Systems.

B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Compound must be capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 31 10 00 "Site Clearing."

3.02 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Feeders 600 V and Less: PVC-40, concrete encased unless otherwise indicated.

B. Duct for Electrical Branch Circuits: PVC-80, direct buried unless otherwise indicated.

C. Underground Ducts Crossing Paved Paths Walks and Driveways : encased in reinforced concrete.

D. Underground Ducts Crossing Roadways : PVC-40, encased in reinforced concrete.

E. Underground Ducts within 10 feet of all manholes and building entrances: encased in reinforced concrete.

F. Stub-ups: Concrete encased, ERMC-S.

3.03 SELECTION OF UNDERGROUND ENCLOSURES

A. Handholes and Boxes:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-10 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf vertical loading.
5. Cover design load must not exceed load rating of handhole or box.

B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Restore area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."

E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.05 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Steel raceway, bends, and fittings in on Project must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
5. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch.
6. Curves and Bends:

a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch 25 ft, both horizontally and vertically, at other locations unless otherwise indicated.
b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
c. Duct must have maximum of 180 degrees of bends between pull points.

7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete for minimum of 12 inch on each side of coupling.

    a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch below grade or floor level and do not terminate in hubs.

8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F. Where environmental temperatures are calculated to rise above 104 deg F, and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inch o.c. for 5 inch duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to end-bell spacing 10 ft from end bell, without reducing duct slope and without forming trap in line.
    b. Grout end bells into structure walls from both sides to provide watertight entrances.

10. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch o.c. for 4 inch duct, and vary proportionately for other duct sizes.

    a. Begin change from regular spacing to terminator spacing 10 ft from terminator, without reducing duct line slope and without forming trap in line.

11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

    a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete for minimum of 12 inch on each side of coupling.

13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig hydrostatic pressure.
14. Pulling Cord: Install 200 lbf test nylon cord in empty ducts.
15. Concrete-Encased Ducts and Duct Bank:

    a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes 6 inch or less in nominal diameter.
    b. Width: Excavate trench 3 inch wider than duct on each side.
    c. Depth: Install so top of duct envelope is at least 24 inch below finished grade in areas not subject to deliberate traffic, and at least 30 inch below finished grade in

deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.

d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft of duct. Place spacers within 24 inch of duct ends. Stagger spacers approximately 6 inch between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

f. Minimum Space between Ducts: 3 inch between edge of duct and exterior envelope wall, 2 inch between ducts for like services, and 4 inch between power and communications ducts.

g. Elbows:

1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.

h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch from edge of equipment base.

1) Stub-ups must be minimum 4 inch above finished floor and minimum 3 inchfrom conduit side to edge of slab.

i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch from edge of wall. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups must be minimum 4 inch above finished floor and no less than 3 inch from conduit side to edge of slab.

j. Reinforcement: Reinforce concrete-encased duct under roadways, within 10 feet of all manholes and building entrances, and where crossing disturbed earth. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

k. Concrete Cover: Install minimum of 3 inch of concrete cover between edge of duct to exterior envelope wall, 2 inch between duct of like services, and 4 inch between power and communications ducts.

l. Place minimum 6 inch of engineered fill above concrete encasement of duct.

m. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch reinforcing-rod dowels extending minimum of 18 inch into concrete on both sides of joint near corners of envelope.

n. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

16. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inch above concrete-encased duct and duct banks and approximately 12 inch below grade. Align tape parallel to and within 3 inch of centerline of duct bank. Provide additional warning tape for each 12 inch increment of duct-bank width over nominal 18 inch. Space additional tapes 12 inch apart, horizontally across width of ducts.
17. Ground ducts and duct banks in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:
1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
1. Cast-in-Place Manholes:

a. Finish interior surfaces with smooth-troweled finish.
b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inch thick, arranged as indicated.
c. Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

2. Precast Concrete Handholes and Manholes:

a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3. Elevations:

a. Manhole Roof: Install with rooftop at least 15 inch below finished grade.
b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
c. Install handholes with bottom below frost line, below grade.
d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
e. Where indicated, cast handhole cover frame integrally with handhole structure.

4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.

a. Install chimney, constructed of precast concrete collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.

6. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
7. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
8. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
9. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch for manholes and 2 inch for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
10. Ground manholes, handholes, and boxes in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.07 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:
1. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Install handholes and boxes with bottom below frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.

a. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with troweled finish.
b. Dimensions: 10 inch wide by 12 inch deep.

8. Ground handholes and boxes in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.08 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Round sleeves.
   2. Sleeve seal systems.
   3. Grout.

B. Related Requirements:
   1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

A. Wall Sleeves, Steel:
   1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.02 SLEEVE SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. CALPICO, Inc.
   2. Metraflex Company (The).
   3. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Fiber-reinforced plastic.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
   1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
   2. Design Mix: 5000 psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Vibration isolators.
2. Neoprene Isolation Washers and Grommets
3. Restraints - rigid type.
4. Restraints - cable type.
5. Restraint accessories.
6. Post-Installed concrete anchors.
7. Concrete inserts.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 29 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated load capacity for each seismic - and wind-load-restraint device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic - and wind-load-restraint component used.
3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an evaluation service member of ICC-ES.
4. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal for Each Seismic-Restraint Device: Not required for this project seismic category.

D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
1. For each wind-load protection device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by an NRTL for reinforcement use.
c. Wind-Load Design Calculations: Submit static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

2. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified structural professional engineer to design seismic and wind-load control system in accordance with criteria specified in Section 26 00 10 "Supplemental Requirements for Electrical".

B. Seismic - and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.

C. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic - and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:
1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.02 VIBRATION ISOLATORS

A. Type DN - Double-deflection neoprene type, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. Kinetics Noise Control RD,
b. Mason ND,
c. Vibration Eliminator T44 or D44,
d. VMC Group R or RVD, or
e. Vibro-Acoustics RD

B. Type NH: Double-deflection neoprene or natural rubber hanger type, with neoprene or natural rubber grommet between hanger rod and housing. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. Kinetics Noise Control RH,
b. Mason HD,
c. Vibration Eliminator C,
d. VMC Group HR,
e. or Vibro-Acoustics NH

C. Elastomeric Isolation Pads: NP.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Ribbed or waffled on both sides.
6. Minimum thickness 0.75 inches.
7. Load-bearing metal plates adhered to pads as recommended by isolation pad manufacturer for loading conditions.
8. Sandwich-Core Material: Resilient and elastomeric.

2.03 NEOPRENE ISOLATION WASHERS AND GROMMETS

A. Neoprene Isolation Washers and Grommets: IWG.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings & Controls, Inc.
e. Vibro-Acoustics.

2. Neoprene isolation washer and grommets shall have a nominal durometer of Shore 50A.

2.04 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mountings & Controls, Inc.
8. Vibro-Acoustics.

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.05 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.

7. Vibration Mountings & Controls, Inc.
8. Vibro-Acoustics.

B. Seismic - and Wind-Load-Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.06 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CADDY; nVent.
2. Gripple Inc.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Mounting & Controls, Inc.
8. Vibro-Acoustics.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.07 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DeWALT.
b. Hilti, Inc.
c. Simpson Strong-Tie Co., Inc.

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.
1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.
1. Undercut expansion anchors are permitted.

2.08 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. DeWALT.

2. Gripple, Inc.
3. Hilti, Inc.
4. International Seismic Application Technology (ISAT).
5. Simpson Strong-Tie Co., Inc.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

C. Comply with MSS SP-58.

PART 3 - EXECUTION

3.01 VIBRATION ISOLATION

A. General:

1. Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.
2. Vibration isolators shall be installed and connected, as specified herein, or as indicated on the Drawings, in accordance with the manufacturer's written instruction and certified submittal data.

B. Equipment isolation:

1. Floor-mounted transformers shall be mounted on Type DN isolators with a minimum static deflection of 0.1".
2. Suspended transformers shall be supported with Type NH isolators with a minimum static deflection of 0.1".

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
1. Labels shall match the color scheme outlined in 2.2.E.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and conductors.
1. Wires shall be color coded for the entire lengths. Field application of marking tape is not allowed.
2. Colors for 208/120-V Circuits:

a) Phase A: Black.
b) Phase B: Red.
c) Phase C: Blue.
d) Neutral: White

3. Colors for 480/277-V Circuits:

a) Phase A: Brown.
b) Phase B: Orange.
c) Phase C: Yellow.
d) Neutral: Gray.

4. Color for Equipment Grounds: Green.
5. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Warning Label Colors:
1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:
1. Blue surface with white core for 120/208-volts equipment.
2. Black surface with white core for 277/480-volts equipment.
3. Bright red surface with white core for all equipment related to fire alarm system.
4. Green surface with white core for all equipment related to emergency systems.
5. Legally required and optional standby systems shall not be uniquely identified and shall retain the nameplate color consistent with their system voltage.
6. Brown surface with white core for all equipment related to data systems.
7. Dark red (burgundy) surface with white core for all equipment related to security.
8. Orange surface with white core for all equipment related to telephone systems.
9. Purple surface with white core for all equipment related to TV systems.

2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
1. Manufacturers: Subject to compliance with requirements, undefined:

a) Brady Corporation.
b) emedco.
c) HellermannTyton.
d) LEM Products Inc.
e) Marking Services, Inc.
f) Panduit Corp.
g) Seton Identification Products; a Brady Corporation company.

B. Self-Adhesive Wraparound Labels: Preprinted Write-on, 3-mil- thick, polyester vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Brady Corporation.
b) emedco.
c) Ideal Industries, Inc.
d) LEM Products Inc.
e) Marking Services, Inc.
f) Panduit Corp.
g) Seton Identification Products; a Brady Corporation company.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels:

a) Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a) Brady Corporation.
      b) emedco.
      c) HellermannTyton.
      d) Ideal Industries, Inc.
      e) LEM Products Inc.
      f) Marking Services, Inc.
      g) Panduit Corp.
      h) Seton Identification Products; a Brady Corporation company.
   2. Minimum Nominal Size:
      a) 1-1/2 by 6 inches for raceway and conductors.
      b) 3-1/2 by 5 inches for equipment.
      c) As required by authorities having jurisdiction.

2.04 BANDS AND TUBES

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

B. TAPES AND STENCILS
   1. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
      a) Manufacturers: Subject to compliance with requirements, undefined:
         1) Carlton Industries, LP.
         2) HellermannTyton.
         3) Ideal Industries, Inc.
         4) Marking Services, Inc.
         5) Panduit Corp.

C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a) Brady Corporation.
      b) Carlton Industries, LP.
      c) emedco.
      d) Marking Services, Inc.

D. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
   1. Manufacturers: Subject to compliance with requirements, undefined:
      a) HellermannTyton.
      b) LEM Products Inc.
      c) Marking Services, Inc.
      d) Seton Identification Products; a Brady Corporation company.

E. Underground-Line Warning Tape:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Brady Corporation.
b) Ideal Industries, Inc.
c) LEM Products Inc.
d) Marking Services, Inc.
e) Seton Identification Products; a Brady Corporation company.

2. Tape:

a) Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b) Printing on tape shall be permanent and shall not be damaged by burial operations.
c) Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

a) Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b) Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c) Inscriptions for Orange-Colored Tapes: "TELEPONE/DATA", "TELEVISION", "SECURITY", and FIRE COMMUNICATIONS".

4. Tape :

a) Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b) Width: 3 inches.
c) Overall Thickness: 8 mils.
d) Foil Core Thickness: 0.35 mil.
e) Weight: 34 lb/1000 sq. ft.
f) Tensile according to ASTM D882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.05 ARC-FLASH WARNING LABELS

A. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

a) Arc-flash boundary.
b) Restricted approach boundary.
c) Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Available fault current.
8. Working distance.
9. Engineering report number, revision number, and issue date.

B. Labels shall be machine printed, with no field-applied markings.

C. The necessary information to be incorporated into each arc flash hazard label shall be furnished to the Contractor by the Engineer per specification Section 26 00 10.

D. Labels shall be provided for electrical equipment, such as panelboards, meter socket enclosures that is likely to require examination, adjustment, servicing, or maintenance while energized as listed within paragraph 3.3.N.

2.06 TAGS

A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Brady Corporation.
b) Carlton Industries, LP.
c) emedco.
d) LEM Products Inc.
e) Marking Services, Inc.
f) Panduit Corp.
g) Seton Identification Products; a Brady Corporation company.

2.07 SIGNS

A. Engraved laminated phenolic Nameplates and Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a) Brady Corporation.
b) Carlton Industries, LP.
c) emedco.
d) Marking Services, Inc.
e) Seton Identification Products; a Brady Corporation company.

2. Engraved legend.
3. Thickness:

a) For signs up to 20 sq. in., minimum 1/16 inch thick.
b) For signs larger than 20 sq. in., 1/8 inch thick.

2.08 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."

L. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

N. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

O. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

P. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

Q. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

S. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

T. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using plenum-rated cable ties.

U. Engraved laminated phenolic Nameplates and Signs:
1. Attach nameplates and signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

V. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

W. Arch-flash labels:

1. Provide self-adhesive labels.

2. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

3.03 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. All panelboards supplied by feeders shall be permanently marked to indicate each equipment where the power originates. The label shall be self-adhesive type and permanently affixed.

D. Prior to energizing, all equipment shall be properly identified with equipment identification, equipment controlled, panel and circuit feeding equipment, electrical ratings and date of installation.

E. All outlet boxes, junction boxes, and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined for Equipment Identification Labels. This includes covers on boxes above lift-out and other type accessible ceilings.

F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.

I. Empty Conduits and Conductors to Be Extended in the Future: Identification shall be by tags with cord or wire attached to conduit or fitting and shall indicate where they terminate.

J. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels Baked-enamel warning signs.
1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a) Power-transfer switches.
b) Controls with external control power connections.

N. Arc Flash Warning Labeling:

1. Each piece of equipment listed below shall have an arc-flash label applied to it:
a) All panelboards, enclosed circuit breakers, enclosed safety switches.
b) Variable frequency motor controllers.
c) Motor Disconnects
d) Elevator Controllers.

O. Operating Instruction Signs: Laminated engraved phenolic signs.

P. Emergency Operating Instruction Signs: Baked-enamel warning signs Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

Q. Equipment Identification Labels:
1. Indoor Equipment: Laminated engraved phenolic sign.
2. Outdoor Equipment: Laminated engraved phenolic sign.
3. Equipment to Be Labeled:

a) Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label. Panelboards and equipment enclosures containing selectively coordinated overcurrent protection devices shall be legibly marked in field to indicate that the overcurrent devices are selectively coordinated. The marking shall state the following:
“CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELLY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED”
b) Enclosures and electrical cabinets.

c) Access doors and panels for concealed electrical items.

d) Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
e) Emergency system boxes and enclosures.
f) Enclosed switches. Each disconnecting means shall be legibly marked to indicate its purpose
g) Enclosed circuit breakers. Each disconnecting means shall be legibly marked to indicate its purpose.
h) Enclosed controllers.
i) Push-button stations.
j) Power-transfer equipment.
k) Contactors.
l) Remote-controlled switches, dimmer modules, and control devices.
m) Monitoring and control equipment.
n) Wiring Devices.
o) Lighting Relay Panels.
p) Lighting Control System head end and all associated system components.

END OF SECTION26 05 53

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this section.

1.2 SUMMARY

A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DESCRIPTION

A. Refer to Division 01 Section “General Commissioning Requirements” for the description of commissioning.

1.4 SUBMITTALS

A. Refer to Division 01 Section “Submittals” for specific requirements. In addition, provide the following:

B. In addition, provide the following:
1. Certificates of readiness
2. Certificates of completion of installation, prestart, and startup activities.
3. O&M manuals
4. Test reports

1.5 QUALITY ASSURANCE

A. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer’s calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to CxA upon request.

1.6 COORDINATION

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup, initial checkout and functional performance testing shall be provided by the Contractor for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.

B. Special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing shall be included in the base bid price to the Owner and left on site, except for stand-alone data logging equipment that may be used by the CxA.

C. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

D. Data logging equipment and software required to test equipment will be provided by the CxA, but shall not become the property of the Owner.

E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, duty cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA..

B. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

C. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.

D. Tests will be performed using design conditions whenever possible.

E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

F. The CxA may direct that set points be altered when simulating conditions is not practical.

G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

H. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.3 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. **Equipment Testing and Acceptance Procedures:** Testing requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.

B. **Electrical Instrumentation and Control System Testing:** Assist the CxA with preparation of testing plans.

C. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated:

1. ***Electrical Distribution System***
2. ***Lighting Controls***

3.4 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.5 APPROVAL

A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.6 DEFERRED TESTING

A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Outdoor photoelectric switches, solid state, flexible mounting.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Digital timer light switch.
5. Conductors and cables.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 27 26.11 "General – Use – Switches, Dimmer Switches, and Fan – Speed Controller Switches" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.
3. Section 26 09 43.16 "Addressable Luminaire Lighting Controls" for networked lighting control requirements.

1.02 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.

B. Shop Drawings:
1. Installation details showing manufacturer requirements.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.
4. Occupancy sensor coverage drawings, indicated sensor coverage pattern and locations.

C. Field quality-control reports.

1.03 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.04 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
1. Failures include, but are not limited to, the following:
a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.
2. Extended Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products shall be compatible with DALI lighting control system as outlined in Section 26 09 43.16.

B. Like products shall be provided by the same manufacturer.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process.

B. Description:

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council to label electrical and mechanical equipment.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Mounting: 1/2 inch threaded male conduit.
5. Failure Mode: Luminaire stays ON.

2.03 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process.

B. General Requirements for Sensors:
1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Passive infrared.
3. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council to label electrical and mechanical equipment.
4. Operation:
   a. Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
5. Mounting:
   a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft. when mounted on a 10 ft. high ceiling.

2.04 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Bus Power Supply: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. DALI-2 Wiring: Multi-core cable suitable for use on the DALI-2 system.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve 100 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.03 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

E. DALI-2 wiring shall be installed within raceways in walls, above hard/inaccessible ceilings, and in areas without ceilings.

F. DALI-2 wiring is intended to be installed within the same raceway as the power conductors serving the luminaires. DALI-2 wiring for emergency luminaires shall be installed within the same raceway as the emergency power wiring (NEC Article 700).

3.04 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 26 05 53 "Identification for Electrical Systems.
   1. Identify devices associated with DALI-2 system with a unique name to match programming information.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operational Test: After installing sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:
   1. Lighting control devices will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Start-up Services:

   1. Engage a third-party integrator to perform system design and startup service. Third-party integrator scope will include the following:
      a. Preparation of product submittals in coordination with the Contractor. Products included in the submittal shall utilize the DALI-2 certification program.
      b. Installation and startup checks according to DALI-2 certification requirements.
      c. Activate control devices.
      d. Confirm correct communications wiring, initiate communications between DALI-2 devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Final Acceptance, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Outdoor photoelectric switches, solid state, flexible mounting.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Digital timer light switch.
5. Conductors and cables.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 27 26.11 "General – Use – Switches, Dimmer Switches, and Fan – Speed Controller Switches" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.
3. Section 26 09 43.16 "Addressable Luminaire Lighting Controls" for networked lighting control requirements.

1.02 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.

B. Shop Drawings:
1. Installation details showing manufacturer requirements.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.
4. Occupancy sensor coverage drawings, indicated sensor coverage pattern and locations.

C. Field quality-control reports.

1.03 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

1.04 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.
1. Failures include, but are not limited to, the following:
a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.
2. Extended Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products shall be compatible with DALI and/or KNX lighting control system as outlined in Section 26 09 43.16.

B. Like products shall be provided by the same manufacturer.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. Description:
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council to label electrical and mechanical equipment.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Mounting: 1/2 inch threaded male conduit.
5. Failure Mode: Luminaire stays ON.

2.03 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. General Requirements for Sensors:
1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Passive infrared.
3. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council to label electrical and mechanical equipment.
4. Operation:
a. Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
5. Mounting:
a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft. when mounted on a 10 ft. high ceiling.

2.04 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Bus Power Supply: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Low Voltage Wiring: Multi-core cable suitable for use on the DALI-2/KNX system or 600V wiring, minimum #14 gauge .

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SENSORS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve 100 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.03 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.

C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

E. DALI-2/KNX wiring shall be installed within raceways in walls, above hard/inaccessible ceilings, and in areas without ceilings.

F. DALI-2 wiring serving DALI-2 LED drivers is intended to be installed within the same raceway as the power conductors serving the luminaires. DALI-2 wiring for emergency luminaires shall be installed within the same raceway as the emergency power wiring (NEC Article 700).

G. DALI-2/KNX wiring serving occupancy sensors, control stations, and other lighting control accessories can be installed separately from power conductors.

3.04 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 26 05 53 "Identification for Electrical Systems.
   1. Identify devices associated with DALI-2/KNX system with a unique name to match programming information.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operational Test: After installing sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:
   1. Lighting control devices will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Start-up Services:

   1. Engage a third-party integrator to perform system design and startup service. Refer to drawings for additional requirements regarding the lighting controls integrator. Third-party integrator scope will include the following:
      a. Preparation of product submittals in coordination with the Contractor. Products included in the submittal shall utilize the DALI-2 certification program or be KNX compatible with non-proprietary communication systems.
      b. Installation and startup checks.
      c. Activate control devices.
      d. Confirm correct communications wiring, initiate communications between DALI-2/KNX devices and controller/gateways, and program the lighting control system

according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.06 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Final Acceptance, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
   1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

END OF SECTION

SECTION 26 09 43.16 - ADDRESSABLE LUMINAIRE LIGHTING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Bus power supply.
2. Controller/gateways.
3. User interface.
4. Lighting control system management software.
5. Luminaire switching and dimming modules.
6. Ballast switching and dimming modules.
7. Sensors.
8. Relays.
9. Manual switches and plates.

1.02 DEFINITIONS

A. DALI: Digital addressable lighting interface.

B. Data Bus: Two wires used to communicate with bus connected devices.

C. Device: A collective term for DALI-compliant bus connected devices, including LED drivers, LED luminaires, manual switches, switching relays, and similar. Sometimes also called "slave unit."

D. Group: A set of devices that respond at the same time to messages on the data bus.

E. KNX: Open protocol control system for building automation.

F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

G. Scene: Digital light level associated with a preset; stored in the luminaire ballast.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.
5. Connection diagrams.

B. Shop Drawings:
1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
2. Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device, and device groups. The plans must be based on construction plans, using the same legend, symbols, and schedules.
3. Point List and Data Bus Load: Summary list of all control devices, sensors, drivers, and other loads connected to each data bus and total connected load for each data bus. Include percentage of rated connected load and device addresses.
4. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Include data

communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Software: Failure of input and output to execute switching or dimming commands.
      b. Failure of modular relays to operate under manual or software commands.
      c. Driver failure.
      d. Damage of electronic components due to transient voltage surges.
   2. Warranty Periods:
      a. For DALI-2 Drivers: Five years from date of Substantial Completion.
      b. For Control Components That Are Not Part of Drivers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. DALI-2:
   1. Components: Individually addressable devices (such as drivers, sensors, relays, dimmers, and switches) that are operated from digital signals received through a DALI-2 compliant bus, from data-entry and -retrieval devices (such as computers, Internet portals, hand-held IR programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and -retrieval devices though the bus.
   2. Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component must be automatically isolated and not affect global system functions.

B. Interface with KNX communication protocol: Hardware and software must interface with KNX protocol to monitor, control, display, and record data for use in processing reports.

C. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge protective device complying with UL 1449, SPD Type 2.

D. Operation: Input signal from digital signal sources switches or dims DALI-2/KNX devices associated with drivers or luminaires, or switches field-deployed, DALI-2 compliant or KNX compliant, control relays.
   1. Each device and relay is connected to a digital data bus.
   2. Each DALI-2 device and relay has a digital address and can be operated by a digital signal.
   3. Each device or relay can be assigned to any or all of 16 available groups connected to a single data bus.
   4. Each dimming driver may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to driver and may be applied to groups.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Products: Products provided as part of the system shall be DALI-2 certified or compatible with KNX protocol and have non-proprietary communication system.

G. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

H. Comply with protocol described in IEC 60929, Annexes E and G, for DALI lighting control devices, wiring, and computer hardware and software.

I. Comply with IEC 62386.

J. Comply with UL 916.

K. Comply with ISO/IEC 14543-3.

L. Like products shall be by one manufacturer.

2.02 BUS POWER SUPPLY

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. Description: Supply power to data bus for 64 control gear addressable devices and 64 control addressable devices, suitable for use with NFPA 70, Class 2 control circuit.
1. Primary Power: Field selectable, 120 and 277 V.
2. Power Supply: Regulated to maintain the operating voltage above 15 V(dc) under full load, and rated for full charging load of 250 mA and a minimum maintained connected load of 190 mA.
3. Pilot Lights: Indicate data bus ground-fault and data bus traffic.

2.03 CONTROLLER/GATEWAYS

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. Description: DALI-2 or KNX controller/gateways link the distributed data buses with an Ethernet network to provide computer configuration, control, analysis, and maintenance. Controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the LAN. Controller/gateways must provide local intelligence and features including the following:
1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
2. Integrated sunrise/sunset support based on the site location (latitude and longitude).
3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
4. Two digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.
5. Support two data bus(es).
6. Computer Monitoring and Configuration: The controller/gateway must allow configuration, monitoring, and analysis from PCs on the Ethernet LAN.

C. Each data bus must have the capacity to control 64 control gear addressable devices and 64 control addressable devices, using NFPA 70, Class 2 control circuit.
1. Each data bus must have the capacity to control up to 16 groups and scenes.
2. 10 BaseT Ethernet port for DDC system for HVAC connection.
3. LED indicator lights for Ethernet status (link, send, and receive), power-on, and LAN failure.
4. Linking of switch and sensor inputs to relay and ballast outputs.
5. Viewing relay and driver output status.
6. Controlling relay and driver outputs.
7. Setting device addresses.
8. Assigning switch and sensor inputs and relay and ballast output modes.

D. Allow connection of the following DALI-2 or KNX compliant addressable devices:
1. LED luminaire switching and dimming.
2. Occupancy, vacancy, and photoelectric sensors.
3. Emergency lighting interface complying with UL 924.

E. Stores system programming in nonvolatile memory.
1. Switch to enable or disable software programming.

2.04 USER INTERFACE

A. Provide equipment and interfaces listed below:
   1. Workstations: A laptop PC, with Microsoft Windows operating system and lighting control system management software installed with automatic backup. Software shall be ETS Professional or approved equal.
      a. Include documentation, storage media, and licensing for a minimum of five concurrent users.
   2. Tablet Computer: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier. The software must provide for all DALI-2/KNX protocol programming commands to be applied to the controller/gateway via a tethered connection.
   3. Web Interface: Internet portal, with one unique username and password(s), and a custom graphical user interface, allowing DALI-2/KNX protocol programming commands to be applied to the controller gateway via LAN.
   4. IR Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.05 LIGHTING CONTROL SYSTEM MANAGEMENT SOFTWARE

A. The software must provide for programming, configuring, and monitoring all devices connected to all data buses of the lighting control system, using application-specific software with Microsoft Windows-based, user-friendly software with graphical user-interface designed screens.
   1. The software must be object oriented with pop-up menus and built-in help screens. All specified features of the data-bus-connected devices and those associated with controller/gateways must be included in the software.
   2. Software shall be ETS Professional or approved equal.

2.06 DRIVER SWITCHING AND DIMMING MODULES

A. Manufacturers: Products shall be listed in the DALI Alliance product database and shall have completed the DALI-2 certification process or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. Each driver or group must be addressable and must include on-off, fade, dimming, scene settings, and other standard DALI-2/KNX control functions as required to meet the sequence of operation.
   1. Comply with DALI-2 exponential dimming curve calibrated for the connected lamp type, group, and scene settings, and with DALI-2 light-level and configuration commands. Dimmer rise time must be not less than 15 microseconds.

2.07 SENSORS

A. Comply with requirements in Section 26 09 23 "Lighting Control Devices." Products shall be listed in the DALI Alliance product database or products shall be compatible with KNX protocol and have non-proprietary communication system.

B. Indoor Occupancy Sensors: May be powered directly from the DALI/KNX bus or with a standalone power supply. Units powered with a standalone power supply must interface with the lighting control system through an electrically isolated digital input.

2.08 MANUAL SWITCHES AND PLATES

A. Connection Type: DALI-2/KNX compliant protocol. Power must be from the control unit.

B. Push-Button Switches: Modular, tactile style operating over the DALI-2/KNX digital data bus.
   1. Refer to Drawings for switch requirements. Multi-button switches shall control groups of devices to achieve scenes indicated on the Drawings.
   2. LED Pilot Lights: On to indicate that the control is active, or when the manual control is operated.
   3. Match color and style specified in Section 26 27 26 "Wiring Devices."
   4. Integral IR receiver for programming.

C. Wall Plates: Single and multi-gang plates as specified in Section 26 27 26 "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.09 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. DALI-2/KNX wiring: Multi-core cable, rated at 600V, suitable for use on the DALI-2/KNX system or 600V wiring, minimum size #14.

C. Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with Category 6 for horizontal copper cable and with Section 27 15 13 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.01 INSTALLATION OF WIRING

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 23 "Control-Voltage Electrical Power Cables." Minimum conduit size is 3/4 inch.
   1. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. DALI-2 wiring serving DALI-2 LED drivers is intended to be installed within the same raceways as the power conductors serving the luminaires. DALI-2 wiring for emergency luminaires shall be installed within the same raceway as the emergency power wiring (NEC Article 700).

D. DALI-2/KNX wiring serving occupancy sensors, control stations, and other lighting control accessories can be installed separately from power conductors.

3.02 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 26 05 53 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

C. Identify all ceiling-mounted controls with data bus number and device address.

D. Label each device cable within 6 inch of connection to bus power supply or termination block.

3.03 STARTUP SERVICE

A. Engage a third-party integrator to perform system design and startup service. Refer to drawings for additional requirements regarding the lighting controls integrator. Third-party integrator scope will include the following:
   1. Preparation of product submittals in coordination with the Contractor. Products included in the submittal shall utilize the DALI-2 certification program or be KNX compatible with non-proprietary communication systems.
   2. Installation and startup checks.
   3. Activate luminaires.
   4. Confirm correct communications wiring, initiate communications between DALI-2/KNX devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test continuity of each circuit.

B. Field tests must be witnessed by Owner’s commissioning agent.

C. Tests and Inspections:

1. Test each bus controller using local and remote controls.

D. Nonconforming work:
1. Lighting controls will be considered defective if they do not pass tests and inspections.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   3. Include diagrams for power, signal, and control wiring.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. Siemens Industry, Inc., Energy Management Division.
   3. Square D; Schneider Electric USA.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use. Third

party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

C. Transformers Rated 15 kVA and Larger:
1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.
1. NEMA 250, Type 2 : Core and coil shall be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.

a. Finish Color: Gray weather-resistant enamel.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

K. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.
3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.
5. 150.01 to 300.00 kVA: 58 dBA for K-factors of 13 and 20.

2.04 IDENTIFICATION

A. Nameplates: Provide equipment label for each distribution transformer as specified in Section 26 05 53 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Secure transformer to concrete base according to manufacturer's written instructions.

C. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

D. Remove shipping bolts, blocking, and wedges.

E. Vibration Isolation Accessories: For vibration isolation mounting accessories, comply with requirements in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems"

3.03 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection.

      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
      e. Perform specific inspections and mechanical tests recommended by manufacturer.

f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

B. Related Requirements:

   1. Refer to section 26 67 10 "Surge Protective Devices" for surge protective devices.

1.03 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. MCCB: Molded-case circuit breaker.

E. SPD: Surge protective device.

F. VPR: Voltage protection rating.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details.
   2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   4. Detail bus configuration, current, and voltage ratings.
   5. Short-circuit current rating of panelboards and overcurrent protective devices.
   6. Include evidence of NRTL listing for SPD as installed in panelboard.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Include wiring diagrams for power, signal, and control wiring.
   9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.08 FIELD CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.01 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council to label electrical and mechanical equipment.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Flush and Surface-mounted, dead-front cabinets.
1. Rated for environmental conditions at installed location.

a. Shall be door-in-door type construction with concealed hinges
b. Indoor Dry and Clean Locations: NEMA 250, Type 1.
c. Outdoor Locations: NEMA 250, Type 3R.
d. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
e. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
f. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

E. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

F. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Terminations shall allow use of 75 deg C rated conductors without derating.
2. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
3. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
4. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
5. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
6. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

G. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.02 SURGE PROTECTION DEVICES

A. Manufacturers: Same as panelboard manufacturer.

B. Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

C. Refer to specification section 26 67 10 “Surge Protective Devices” for additional requirements.

D. Each unit shall incorporate an integral test feature to verify the operational integrity of the unit's monitoring system.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 150kA for devices installed in distribution and power panelboards and not less than 100kA for devices installed in branch circuit panelboards. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

2.03 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; Schneider Electric USA.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker Fused switch Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; Schneider Electric USA.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; Schneider Electric USA.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.
c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

a. RMS sensing.
b. Field-replaceable rating plug or electronic trip.
c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.

3) Long and short time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Ground-Fault Protection: Integrally mounted Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
f. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

2.06 INSTRUMENTATION

A. Instruments shall be mounted integral to the panelboard with the meter's display visible without removing the dead front cover.

1. Electronic power monitors with digital LCD or LED display, minimum 1% accuracy, on the load side of the main breaker or main lugs. Monitors shall be microprocessor-based devices with nonvolatile memory, local display of information, and Modbus RTU capabilities. Metered values (true RMS) shall include multiphase A and volts, watts, VARS, volt-amperes, watt-hours and VAR-hours, watts demand, frequency, and power factor.
2. Manufacturer: Eaton IQ35M series, GE EPM 6000, Siemens PAC4200, or Square D PM5563

2.07 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

1. SPDs shall be integrated within panelboards and shall be direct bus bar mounted.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

O. Mount spare fuse cabinet in accessible location.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated in coordination study report.

3.06 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes work to accommodate utility company revenue meters, and Owner's electricity meters used to manage the electrical power system.

1.03 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.04 ACTION SUBMITTALS

A. Product Data:
   1. For each type of meter.
   2. For metering infrastructure components.
   3. For metering software.

B. Shop Drawings: For electricity-metering equipment.
   1. Include elevation views of front panels of control and indicating devices and control stations.
   2. Include diagrams for power, signal, and control wiring.
   3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
   4. Include series-combination rating data for modular meter centers with main disconnect device.
   5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.05 COORDINATION

A. Electrical Service Connections:
   1. Coordinate with utility companies and utility-furnished components.
      a. Comply with requirements of utility providing electrical power services.
      b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

B. Comply with UL 916.

2.02 UTILITY METERING INFRASTRUCTURE

A. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.
   1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725.

B. Arc-Flash Warning Labels.
   1. Labels: Apply label for each work location. The necessary information to be incorporated into each arc flash hazard label shall be furnished to the Contractor by the Engineer per specification Section 26 00 10.
   2. Labels: Comply with requirements for "Equipment Labels" and "Signs" in Section 26 05 53 "Identification for Electrical Systems." Apply label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

2.03 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. ABB, Electrification Business.
   2. Eaton.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; Schneider Electric USA.
   5. Comply with ANSI C12.1 and ANSI C12.20, 0.5 accuracy class.
   6. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
   7. Humidity: Zero to 95 percent, noncondensing.
   8. Capacities and Characteristics:

      a. Circuit: 120/240-V ac, 100 A.
      b. Measure: kWh, onboard LED display.
      c. Remote-Reading Options: None.

C. General Requirements for Meters:

   1. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
   2. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 minimum, with provisions for locking or sealing.
   3. Identification: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
   4. Onboard Nonvolatile Data Storage: kWh, until reset.

5. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: solid core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic three-phase meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.

E. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install arc-flash labels as required by NFPA 70.

C. Wiring Method:

1. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 27 15 13 "Communications Copper Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch.

3.02 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

END OF SECTION

SECTION 26 27 26.11 - GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. General-use switches.
2. General-use dimmer switches.

B. Related Requirements:
1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 09 23 " Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
3. Section 26 09 43.23 "Relay-Based Lighting Controls" for network lighting control relay devices.

1.02 ACTION SUBMITTALS

A. Product Data:
1. Toggle switches.

PART 2 - PRODUCTS

2.01 GENERAL-USE SWITCHES

A. Description: Snap switches intended for mounting in device boxes.

B. Performance Criteria:
1. Regulatory Requirements:
a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

2. General Characteristics:

a. Reference Standards: UL CCN WMUZ and UL 20.

C. Toggle Switch :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
b. Leviton Manufacturing Co., Inc.
c. Pass & Seymour; Legrand North America, LLC.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Options:

a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits
b. Configuration:

1) Extra-heavy-duty, 120-277 V, 20 A, single pole double pole three way four way.
2) Extra-heavy-duty, 120-277 V, 30 A, single pole double pole three way.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

a. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

3.02 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 27 26.33 – FEDERAL SPECIFICATION -GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Duplex straight-blade receptacles.

B. Related Requirements:
   1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 26 27 26.37 "Receptacles with Arc-Fault and Ground-Fault Protective Devices" for AFCI and GFCI receptacles.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. Duplex straight-blade receptacles.

PART 2 - PRODUCTS

2.01 DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Description: Federal specification-grade duplex receptacles for use in wiring systems recognized by NFPA 70.

B. Performance Criteria:
   1. Regulatory Requirements:

      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

   2. General Characteristics:

      a. Reference Standards:

         1) UL CCN RTRT and UL 498.
         2) Surge Protective Devices: UL 1449, Type 3.

C. Duplex Straight-Blade Receptacle :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
      b. Leviton Manufacturing Co., Inc.
      c. Pass & Seymour; Legrand North America, LLC.
      d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

   2. Options:

      a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits.
      b. Configuration:

1) Extra-heavy-duty, NEMA 5-20R.
2) Extra-heavy-duty, NEMA 6-20R.

D. Weather-Resistant Duplex Straight-Blade Receptacle :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
b. Leviton Manufacturing Co., Inc.
c. Pass & Seymour; Legrand North America, LLC.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Options:

a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits
b. Configuration:

1) Extra-heavy-duty, NEMA 5-20R.

E. Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
b. Leviton Manufacturing Co., Inc.
c. Pass & Seymour; Legrand North America, LLC.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Options:

a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits.
b. Configuration:

1) Heavy-duty, smooth face, NEMA 5-20R.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.02 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.04 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 27 26.37 - RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Receptacles with GFCI devices.

B. Related Requirements:
   1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
   2. Section 26 27 26.33 "Federal Specification -Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.

1.02 ACTION SUBMITTALS

A. Product Data:
   1. Receptacles with GFCI devices.

PART 2 - PRODUCTS

2.01 RECEPTACLES WITH GFCI DEVICES

A. Description: Receptacles containing GFCI device for use in accordance with NFPA 70.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.
   2. General Characteristics:
      a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.

C. General-Grade Duplex Straight-Blade Receptacle with GFCI Device:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
      b. Leviton Manufacturing Co., Inc.
      c. Pass & Seymour; Legrand North America, LLC.
      d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.
   2. Options:
      a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits.
      b. Configuration: Heavy-duty, NEMA 5-20R.

D. General-Grade, Weather-Resistant Duplex Straight-Blade Receptacle with GFCI Device :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

b. Leviton Manufacturing Co., Inc.
c. Pass & Seymour; Legrand North America, LLC.
d. Wiring Device-Kellems; Hubbell Incorporated, Commercial and Industrial.

2. Options:

a. Device Color: Gray for use on normal power circuits and Red for use on emergency power circuits.
b. Configuration: Heavy-duty, NEMA 5-20R.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.02 INSTALLATION

A. Comply with manufacturer's instructions.

B. Reference Standards:
1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.04 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Enclosed controllers.
      c. Enclosed switches.
   2. Spare-fuse cabinets.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   3. Current-limitation curves for fuses with current-limiting characteristics.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.05 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bussmann; Eaton, Electrical Sector.
   2. Littelfuse, Inc.

3. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
3. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.03 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:
1. Feeders: Class L, time delay Class RK1, time delay Class J, fast acting.
2. Motor Branch Circuits: Class RK1, time delay.
3. Large Motor Branch (601-4000 A): Class L, time delay.
4. Control Transformer Circuits: Class CC, time delay, control transformer duty.
5. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.03 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and electronic format.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.07 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: One year(s) from date of Final Acceptance.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

D. Comply with NFPA 70.

2.03 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty:
1. Single throw.
2. Three pole.
3. 600-V ac.
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. For HVAC equipment mounted outdoors and equipped with on-board controls provide integral to disconnect switch surge protection device and external window to enable viewing of LEDs on SPD for quick status indication.

2.04 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. 24-V ac 120-V ac.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. For HVAC equipment mounted outdoors and equipped with on-board controls provide integral to disconnect switch surge protection device and external window to enable viewing of LEDs on SPD for quick status indication.

2.05 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Products Division.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated. "

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

O. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Din-rail-mounted communication module with functions and features compatible with building power monitoring and control system.
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Zone-Selective Interlocking: Integral with electronic ground-fault trip unit; for interlocking ground-fault protection function.
12. Electrical Operator: Provide remote control for on, off, and reset operations.

2.06 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover directly operable through the front cover of the enclosure (NEMA 250 Type 1) directly operable through the dead front trim

of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.02 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.03 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.04 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.

3.05 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:

      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
      e. Verify that fuse sizes and types match the Specifications and Drawings.
      f. Verify that each fuse has adequate mechanical support and contact integrity.
      g. Inspect bolted electrical connections for high resistance using one of the two following methods:

         1) Use a low-resistance ohmmeter.

            a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

            a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

      h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
      i. Verify correct phase barrier installation.
      j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

   2. Electrical Tests:

      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
      b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not

available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges to values indicated on the Drawings.

END OF SECTION

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes lightning protection system for ordinary structures.

B. Section includes lightning protection system for the following:
   1. Ordinary structures.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
   2. Include raceway locations needed for the installation of conductors.
   3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
   4. Include roof attachment details, coordinated with roof installation.
   5. Calculations required by NFPA 780 for bonding of metal bodies.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Completion Certificate:
   1. UL Master Label Certificate.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advanced Lightning Technology, Ltd.
   2. East Coast Lightning Equipment Inc.
   3. Harger Lightning & Grounding.
   4. Independent Protection Co.
   5. National Lightning Protection.
   6. Robbins Lightning, Inc.
   7. Thompson Lightning Protection, Inc.

2.02 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.03 MATERIALS

A. Electrical wire and cable shall have lead content less than 300 parts per million.

B. Air Terminals:
   1. Copper unless otherwise indicated.
   2. 5/8-inch diameter by 18 inches long.
   3. Rounded tip.
   4. Threaded base support.

C. Class 1 Main Conductors:
   1. Stranded Copper: 57,400 circular mils in diameter.

D. Class II Main Conductors:
   1. Stranded Copper: 115,000 circular mils in diameter.

E. Secondary Conductors:
   1. Stranded Copper: 26,240 circular mils in diameter.

F. Ground Loop Conductor: Stranded copper.

G. Ground Rods:
   1. Material: Copper-clad steel.
   2. Diameter: 3/4 inch.
   3. Rods shall be not less than 120 inches long.

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lightning protection components and systems according to UL 96A NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A concealed systems in NFPA 780.
   1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
   2. Install conduit where necessary to comply with conductor concealment requirements.
   3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions. Adhesive shall be compatible with the roof material and shall not compromise the warranty of the roof.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.02 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Bonding to the building electrode system.

3.03 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   1. Perform inspections as required to obtain a UL Master Label for system.
   2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.
   1. Upon completion and review by an NCBCC approved third-party lightning protection agency, Contractor shall obtain, and deliver to Owner the certifications.

END OF SECTION

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Materials.
   2. Luminaire support.

B. Related Requirements:
   1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests IES LM-79 and IES LM-80.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.05 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.

B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

PART 2 - PRODUCTS

2.01 WARRANTY

A. Provide a minimum 5 year luminaire warranty. Warranty documentation shall be provided with submittal for luminaire types.

2.02 PERFORMANCE REQUIREMENTS

A. Altitude: Sea level to 1000 feet.

2.03 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

B. Recessed luminaires shall comply with NEMA LE 4.

C. Drivers shall be DALI-2 certified and compatible with DALI-2 system.

2.04 MATERIALS

A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:
1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:
1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

2.05 MAINTENANCE

A. Power supplies/drivers/ballasts, LED arrays, boards or light engines shall be easily field replaceable using common hand tools (e.g., screwdrivers, pliers, etc.) and without uninstalling the luminaire.

B. Where LED luminaire is connected to a circuit greater than 50-volts an integral disconnect plug shall be provided for disconnecting the driver from the circuit.

2.06 ELECTRICAL AND PHOTOMETRIC REQUIREMENTS

A. Operating voltage: 24 Vdc, 120 Vac at 60 Hz, 277 Vac at 60Hz, or universal voltage (120, 220/240, 277 Vac at 50/60 Hz)

B. Power factor: ≥ 0.90 (at full luminaire output and across specified voltage range)

C. Total harmonic distortion: ≤ 20% (at full luminaire output and across specified voltage range).

D. LED drivers shall operate from an input source of 47 Hz to 63 Hz and 90 V to 305 V.

E. Transient and surge protection: Indoor and building mounted exterior fixtures shall be provided with a minimum 2-KV surge suppression integral with the driver. Surge suppression device shall adhere to ANSI C62.41-2002 Category A surge protection standards

F. Sound: Class A not to exceed a measured value of 24dB

G. Maximum standby power: 1W

H. LED arrays in the product(s) will be considered defective in material or workmanship if a total of 10% or more of the individual light-emitting diodes in the product(s) fail to illuminate during normal operation after installation.

I. LED Driver Robustness
1. Driver efficiency (at full load):
a. ≥ 85% for drivers capable of ≥ 50 watts
b. ≥ 80% for drivers capable of < 50 watts
2. Federal Communications Commission (FCC) compliance: FCC 47 Part 15 Non-Consumer limits for EMI/RFI emissions

J. Temperature Rating
1. Each luminaire shall be designed to operate at an average operating temperature of 25°C.
2. The operating temperature range shall be 0°C to 25°C.

K. Thermal management
1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LEDs manufacturer's maximum junction temperature for the expected life shall not be exceeded at the average operating ambient temperature.
3. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient temperature.
4. The driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating temperature. Thermal management shall be passive by design. The use of fans or other mechanical cooling devices shall not be allowed.

L. Flicker criteria
1. Adhere to IESNA standards for flicker and IEEE PAR1789 Recommended Practice to limit flicker to acceptable levels. Flicker needs to be considered at both the luminaire level when fully powered and when dimmed.

M. EMI/RFI
1. The luminaire and associated on-board circuitry shall meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI Emissions.

N. Inrush Current
1. Adhere to NEMA 410 requirements.

2.07 COLORIMETRIC PERFORMANCE

A. Correlated Color Temperature (CCT): Only allowed CCTs are 2700K, 3000K, 3500K, 4000/4100K, 4500K and 5000K

B. Acceptable tolerances as provided in ANSI C78.377-2015 (LED)

C. Color Rendering Index (CRI) [Ra] ≥ 80 with a positive R9 value

D. Color shift of no less than $\Delta u'v' < 0.007$ during the warranty period

2.08 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.09 LUMINAIRE SUPPORT

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting. LED source shall not require replacement after temporary use.

3.03 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:
1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaires:
1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaires:
1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaires:
1. Ceiling Mount:
a. Two 5/32-inch- diameter aircraft cable supports adjustable to 10 feet in length.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

H. Recessed Luminaires:
1. Recessed luminaires shall be supported from the structure independent of the ceiling support system. Provide at least two supports on diagonals where any horizontal dimension of the luminaire is 18" or larger. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track and shall be distinguished by color and tag. Attach one end of the wire to one corner of the luminaire and the other end to the building’s structural system. The lay-in luminaire shall be then secured to the main runners of the lay-in ceiling track at minimum two diagonally opposite corners.

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
   1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Materials.
   2. Finishes.
   3. Luminaire support components.

B. Related Requirements:
   1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaire.
   4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79.
   6. Wiring diagrams for power, control, and signal wiring.
   7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.

2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.07 QUALITY ASSURANCE

A. Provide luminaires from a single manufacturer for each luminaire type.

B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

C. Warranty: Five years at minimum from date of Final Acceptance.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.09 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. L70 lamp life of 50,000 hours.

H. Internal driver. Driver shall be DALI-2 certified and compatible with DALI-2 system

I. Lamp Rating: Lamp marked for outdoor use.

J. Surge suppression: Provide for outdoor pole mounted and ground mounted LED luminaires; surge suppressor shall be minimum 10.0- KV rated and integral to the driver

K. Source Limitations:
1. Obtain luminaires from single source from a single manufacturer.
2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:
1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.03 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
a. Color:
1) As selected by Architect from manufacturer's full range.

2.04 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:
1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
1. Attached to structural members in walls.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.04 INSTALLATION OF BOLLARD LUMINAIRES

A. Align units for optimum directional alignment of light distribution.
1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.05 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.06 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

END OF SECTION

SECTION 26 67 10 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. General provisions and other electrical systems are specified in other Sections of Division 26.

B. This Section covers surge protective devices (SPDs) for low-voltage, 600 V or less, electrical distribution equipment.

1.02 QUALITY ASSURANCE

A. Conform to the following:

1. IEEE C62.41.1
2. IEEE C62.41.2
3. North Carolina State Electrical Code-2020.
4. UL 1283
5. UL 1449 4th edition

B. UL 96A requirements related to SPDs and in coordination with the lightning protection system.

C. SPDs shall have a 5 year warranty.

PART 2 - PRODUCTS

2.01 SURGE PROTECTIVE DEVICES

A. General:

1. UL 1449 voltage protection rating (VPR) label shall be permanently affixed to the units.
2. Maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage.
3. Protection modes: for a wye-configured system, devices shall have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta-configured system, devices shall have suppression elements between line-line (L-L) and line-ground (L-G).
4. Nominal discharge current (in): SPDs applied to the distribution system shall have a 20 kA in rating regardless of their SPD type (including Types 1 and 2) or operating voltage.
5. UL 1449component voltage protection rating shall not exceed the following:

System Voltage	208Y/120	480Y/277
L-N; L-G; N-G	700 V	1200 V
L-L	1200 V	2000 V

6. Electrical noise filter: each unit shall include a high performance EMI/RFI noise rejection filter.
7. Internal connections: internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
8. Overcurrent protection: each unit shall be provided with overcurrent protection to provide both thermal overload protection for small magnitude fault current conditions or temporary over voltage conditions as well as short circuit current protection for high magnitude fault conditions. Each MOV module or element shall be individually fused with 200000 RMS symmetrical AIC internal fuses.
9. Monitoring and Diagnostics:
   a. SPDs shall be equipped with visible indication of proper connection and operation. Indicator lights shall indicate which phase as well as which module is fully operable.
   b. SPDs shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of each enclosure.
   c. SPDs shall be equipped with contacts for remote annunciation of alarm or trouble.
   d. SPDs installed at service entrance locations shall be equipped with a transient event counter.
10. Each unit shall incorporate an integral test feature to verify the operational integrity of the unit's monitoring system.

2.02 SYSTEM APPLICATIONS

A. SPD applications covered under this Section include distribution and branch circuit panelboard locations.

B. SPDs shall be designed and tested for application within IEEE C62.41.1-2002 (R2008) Category C, B, and A environments.

C. Surge current capacity: the minimum surge current capacity that each unit is capable of withstanding shall be as shown in the following table:

IEEE 62.41-2002 (R2008) Location Category	Application	Minimum Surge Current Per Phase	Minimum Surge Current Per Mode *
C	Service entrance (panelboards. main entrance)	250 kA	100 kA
B	Distribution and power panelboards	150 kA	50 kA
A	Branch circuit panelboards,	100 kA	50 kA

A. *L-G, L-N and N-G (wye system); L-L, L-G (delta system).

D. SPD type: SPDs installed on the line side of the service entrance disconnect shall be Type 1. SPDs installed on the load side of the service entrance disconnect shall be Type 2.

E. Panelboard Requirements:

1. Units shall be designed for IEEE C62.41.1-2002 (R2008) and IEEE C62.41.2-2002 (COR 1-2012) Category B environments.

2.03 MANUFACTURER

A. Same as panelboard manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install SPDs in accordance with manufacturer's written instructions.

B. Install SPDs in service entrance equipment.

C. Provide SPDs for distribution panelboards and branch-circuit panelboards where indicated in the Drawings. SPDs shall be installed integral to electrical distribution equipment by the electrical distribution equipment manufacturer.

1. Locate SPDs on the load side of the main disconnect device, as close as possible to the phase conductors and ground and neutral bar.
2. SPDs shall be integrated within panelboards and shall be direct bus bar mounted. FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Compare equipment nameplate data for compliance with drawings and the specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.
4. SPDs that do not pass tests and inspections will be considered defective. Remove and replace defective units and retest.
5. Prepare test and inspection reports.

B. Startup Service:

1. Complete startup checks in accordance with manufacturer's instructions.
2. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
3. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.03 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. TBB: Telecommunications Bonding Backbone

E. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

C. Proposed sizes of BCT and all TBB conductors

1.05 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
1. Ground rods.
2. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-D.

2.02 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products, Inc. (CPI).
2. Eaton (Cooper B-line).
3. Harger Lightning & Grounding.
4. Hubbell.
5. nVent.
6. Panduit Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:
1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

2.03 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products, Inc. (CPI).
2. Eaton (Cooper B-line).
3. Harger Lightning & Grounding.
4. Hubbell.
5. nVent.
6. Panduit Corp.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression -type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

2.04 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Chatsworth Products, Inc. (CPI).
2. Eaton (Cooper B-line).
3. Harger Lightning & Grounding.

4. Hubbell.
5. nVent.
6. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-D.
1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-D.
1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-D. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton (Cooper B-line).
2. Harger Lightning & Grounding.
3. nVent.

B. Ground Rods: Copper-clad steel ; 3/4 inch by 10 feet in diameter.

C. Ground rods to be installed at outdoor telecommunications enclosures, and in telecommunications handholes and manholes.

2.06 IDENTIFICATION

A. Comply with requirements for identification products in Section 27 05 53 "Identification for Communications Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-D.

3.03 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
   1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
   2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
   3. The bonding conductor between the TMGB and the AC service equipment ground shall not be smaller than No. 3/0 AWG.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

C. Conductor Support:
   1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

D. Grounding and Bonding Conductors:
   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
   2. Install without splices.
   3. Support at not more than 36-inch intervals.
   4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

      a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.05 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.

2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space. Provide an exothermic weld for each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

L. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

M. Static Dissipative Flooring.
1. Install grounding tape at static-dissipating flooring in accordance with manufacturer's instructions. Ground to telecommunications or building ground system.

3.06 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.07 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.
   1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
   2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
   3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

      a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

   3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

      a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metallic surface pathways.
4. Nonmetallic surface pathways.
5. Hooks.
6. Boxes, enclosures, and cabinets.
7. Innerduct

1.03 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.04 ACTION SUBMITTALS

A. Product data for the following:
1. Surface pathways
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.

B. Sustainable Design Submittals:
1. Product Data: For adhesives and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For custom enclosures and cabinets and custom underground handholes and boxes. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Seismic Qualification Data: Seismic rating for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.
2. Atkore International (Allied Tube & Conduit).
3. Southwire Company.

C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.
1. Rigid metal conduit shall be galvanized steel. Connectors and couplings shall be threaded galvanized malleable iron or steel. Locknuts shall be of the type with sharp edges that bite into enclosure where connected. Plastic insulating bushings shall be high temperature type. Sealing bushings shall have galvanized malleable iron locking ring with molded neoprene sealing ring with predrilled holes to accommodate each individual conductor, stainless steel screws and washers, PVC-coated pressure discs, and factory-installed lay-in grounding conductor lugs. Hub fittings shall be 2-piece, insulated throat, liquidtight type of steel or malleable construction.

E. EMT: Comply with ANSI C80.3 and UL 797.
1. Electrical metallic tubing shall be galvanized steel. Connectors and couplings shall be malleable iron or steel, galvanized or cadmium-plated, compression type. Connectors shall have insulated throats.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

H. Flexible metal conduit shall be galvanized steel. Connectors shall be of the twist-in, insertion or totally enclosed clamp type, galvanized malleable iron or steel, with insulated throats.

I. Liquidtight flexible metal conduit shall be extra flexible type, neoprene-jacketed. Connectors shall be watertight, of the twist-in, insertion type, galvanized malleable iron or steel, with insulated throats.

2.02 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Carlon; a brand of Thomas & Betts Corporation.
   2. Dura-Line.
   3. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.

C. General Requirements for Nonmetallic Conduits and Fittings:
   1. Rigid nonmetallic conduit shall be rigid polyvinyl chloride, nonburning, high impact. Couplings and connectors shall be rigid polyvinyl chloride, high impact. Cement for connections of conduit shall be approved by the conduit manufacturer.
   2. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
   3. Comply with TIA-569-D.

D. RNC: Type EPC-40-PVC complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Continuous HDPE: Comply with UL 651A.

F. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

G. Solvents and Adhesives: As recommended by conduit manufacturer.
   1. VOC Content: 490 Insert value> g/L or less for PVC conduit and fittings.

2.03 SURFACE METAL PATHWAYS

A. Description:
   1. Galvanized steel with snap-on covers, complying with UL 5.
   2. Surface-mounted raceway shall be two-piece, surface metal type for power and communications service, consisting of base and cover sections. Raceways shall be capable of being internally divided into 2 separate equal compartments for power and communications wiring. Raceway system shall be complete with fittings, elbows, couplings, wire retainer clips, blank ends, and transition pieces to other surface metal raceways and to 0.5" to 1.5" conduit. Raceway system shall also be complete with device brackets for horizontal or vertical single or double gang devices, and combination receptacle and telephone outlet covers.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. MonoSystems, Inc.
   2. Panduit Corp.
   3. Wiremold; Legrand North America, LLC.

C. Finish: Manufacturer's standard enamel finish in color selected by Architect.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.04 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. MonoSystems, Inc.
   2. Panduit Corp.
   3. Wiremold; Legrand North America, LLC.

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.05 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.
2. Raco Taymac Bell; Hubbell Incorporated, Commercial and Industrial.
3. Wiremold; Legrand North America, LLC.

C. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Device Box Dimensions: 4.6875” inches square by 3.25 inches deep unless otherwise noted on Drawings.
4. Gangable boxes are prohibited.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Outlet boxes shall be constructed of code-gauge galvanized steel, unless otherwise specified herein. Where installed in hazardous locations or exposed to corrosive atmosphere, rain or spray, boxes shall be corrosion resistant cast metal with threaded entrances, removable covers, gaskets, and corrosion resistant screws.
1. Outlet boxes recessed in plaster or gypsum board walls or columns shall be 4.675" square, 3.25" deep with plaster rings.
2. Outlet boxes for devices recessed in metal door jambs shall be sheet metal partition boxes sized for the application.
3. Outlet boxes recessed in masonry walls shall be square cornered masonry boxes or standard 4.6875”" square boxes fitted with square cornered tile covers of proper depth for block. Both type boxes shall be 3.25" minimum depth.
4. Outlet boxes recessed in ceilings shall be 4.6875" octagonal or square, 3.25" depth.
5. Outlet boxes recessed in concrete shall be UL approved for the application.
6. Through-wall type outlet boxes are not acceptable.
7. Wall telephone and data outlet boxes shall be 4.6875", 3.25" deep with single-gang device plaster covers and coverplates.
8. Where special purpose devices require a larger outlet box than specified herein, provide outlet boxes for each specific device.
9. Boxes containing low voltage and line voltage devices shall have metal barriers.

G. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Floor boxes in slabs above grade shall be 4.6875" square, 3.25" deep, constructed of galvanized steel with flush knockouts on sides and bottom. Boxes shall be concrete-tight and fully adjustable. A leveling plate with screws at each corner shall be factory welded to the bottom of each box for rough leveling. Adjusting rings mounted to the top of each box shall provide a 0.5" vertical or angular adjustment of the top after concrete pour and installation of wiring devices.
6. Floor boxes for slabs on grade shall be zinc-coated cast iron with integral threaded conduit openings. Boxes shall be watertight, fully adjustable, and constructed to prevent the free entrance of both surface and sub-surface water when the box is embedded in concrete. Boxes shall be provided with a minimum of 2 integral leveling screws for rough leveling.

Adjusting rings shall provide a minimum 0.75" vertical or angular adjustment of the top after concrete pour and installation of wiring devices. A cap shall be provided over the top of each box to protect adjusting ring during concrete pour.

7. Floor plates shall be of aluminum construction, configuration as indicated on the Drawings. Carpet flanges shall be of aluminum construction.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
1. Boxes shall be the type, size and configuration required for its specific use, location, device, and number, size, and arrangement of raceways connecting thereto.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.06 INNERDUCT

A. Fabric Innerduct: Continuous, polyester, multi-pocket fabric innerduct, with internal pull tape.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. 1.25” standard innerduct

2. Indoor Textile Innerduct (Riser-listed): Micro, 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
3. Plenum-Listed Textile Innerduct: Micro, 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
4. Provide two 3" 3-cell fabric innerducts in one of the service entrance conduits. Install per manufacturer specifications.

2.07 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT [**or**].
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1-inch trade size for copper cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 27 05 29 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. The approximate locations of outlets are indicated on the Drawings. The exact locations shall be determined during construction. The right is reserved to change the exact location of any outlet box in any room before it is permanently installed, without additional cost to the Owner and as approved by the Architect and/or Engineer.

I. Arrange stub-ups so curved portions of bends are not visible above finished slab.

J. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

K. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

L. Support conduit within 12 inches of enclosures to which attached.

M. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions or as otherwise directed by Structural Engineer.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

N. Stub-ups to Above Recessed Ceilings:
1. Stub-ups from the backbox to the ceiling are not permitted.
2. All conduit from the backbox shall be routed to the nearest cable tray and terminated with a plastic bushing within 6" of the cable tray.

O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

P. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

R. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

U. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

V. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

X. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a

blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

Y. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Z. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

AA. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints. Raceways shall be run parallel with or at rightangles to the building walls.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

BB. Hooks:
1. Follow manufacturer’s instructions and recommended industry standards and guidelines.
2. Must be an independent support structure for the voice/data communication system.
3. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
4. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
5. Shall be installed using threaded rods secured to the slab above, manufacturer approved clips/clamps secured to structure or wall mounted to support the telecommunications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
6. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
7. Space hooks no more than 5 feet o.c.
8. Provide a hook at each change in direction. Must be routed to follow existingcorridors, and parallel or 90 degree angles from all walls and/or the cable traywhenever possible.

9. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.
10. Contractor installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three feet (3').

CC. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
1. Set outlet boxes for flush-mounted devices to within 0.125" of finished wall.
2. Adjust mounting heights of boxes in masonry walls to minimize cutting and patching of masonry.
3. Install outlet boxes in one vertical line when indicated adjacent on the Drawings but at different mounting heights.
4. Covers on recessed ceiling outlet boxes shall be painted to match the ceiling.

DD. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

EE. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
1. Outlet boxes shall not be installedback-to-back. Maintain minimum 24" separation between outlet boxes on opposite sides of rated walls, and minimum 6" separation in nonrated walls.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits. Install boxes level, plumb, and square to thestructure.
1. Provide knockout closures to cap unused knockout holes where blanks have been removed.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

JJ. Where raceways must pass through structural members, obtain approval from the Architect and/or Engineer regarding location and size of openings prior to drilling. Lateral raceways in masonry shall not exceed 0.75".

KK. Raceways shall be secured in place and protected to prevent damage to the work during construction. Open ends of raceways shall be taped or capped after installation to prevent entry of dirt and debris during construction prior to pulling wire. Installation of raceways shall be complete and shall be blown-out and swabbed clear of water and trash prior to pulling wire.

LL. Rigid metal conduit shall be installed for applications not otherwise specified herein. Rigid metal conduit shall be secured to metal enclosures using hub fittings. Insulated bushings or fittings shall be installed at connections to cabinets and boxes. Terminate stub-ups not attached to enclosures with an insulated throat grounding bushing. Commercial pipe joint compound shall be applied to the male threads on threaded joints and fittings. Connections shall be wrench-tight, and where subject to ground water, rain or spray shall be watertight.

MM. Service provider raceways shall be installed as indicated on the Drawings and shall be coordinated with the local telephone company or other service provider. Raceways terminated at plywood backboards shall be turned-up out of the floor slab to 12" above the finished floor if routed from below, and turned down and terminated at the top of the backboard if routed from above.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.

C. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.

3.05 INSTALLATION OF INNERDUCT

A. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.

B. Select approved innerduct suitable for specific installation environments and/or air handling (plenum) spaces.

C. Exposed standard Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material between textile innerduct and sleeves or fire barrier system.

D. Raceway Penetrations: After textile innerduct installation, install intumescent fire barrier penetration sealing material between textile innerduct and conduit or wire way at all exposed penetration locations.

E. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
   1. Plenum areas: plenum-rated plastic or stainless steel
   2. Non plenum areas: Conventional flame-retardant nylon ties

3.06 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.

1.03 ACTION SUBMITTALS

A. Shop Drawings: For fabrication and installation details for communications hangers and support systems.
1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.04 INFORMATIONAL SUBMITTALS

A. Provide coordination drawings in accordance with Division 1 requirements.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Atkore International (Unistrut).
    b. Eaton (B-line).
    c. nVent (CADDY).

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Material for Channel, Fittings, and Accessories: Galvanized steel.
4. Channel Width: Selected for applicable load criteria.
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.

    2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

        a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

            1) Eaton (B-line).
            2) Hilti, Inc.
            3) MKT Fastening, LLC.

    3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
    4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
    5. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-D.
   4. NECA 101.
   5. NECA 105.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 3/8 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps, using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Use expansion anchor fasteners.
   5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Cable tray accessories.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.
1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

2.02 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.03 LADDER CABLE TRAY (CABLE RUNWAY WITHIN TELECOM ROOMS)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Eaton (B-line).

a. Part #: SB1712FB

B. Description:
1. Ladder cable tray shall form a wireway system for cable management inside communications rooms.
2. Runways shall be classified by UL and rated as an equipment grounding conductor.
3. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
4. Width: 12-inches unless otherwise indicated on Drawings.
5. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
6. Rung Spacing: 9 inches o.c.
7. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
8. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
9. No portion of the rungs shall protrude below the bottom plane of side rails.
10. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
11. Cable Runway Accessories

a. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as ladder cable tray.
b. Barrier Strips: Same materials and finishes as for ladder cable tray.
c. Specific Accessory Products: Furnish and install all accessories, including but not limited to radius drops, splice kits, support kits, end closing kits, protective end caps, ground wire supports, elevation kits, and other accessories as indicated on the project drawings, and as required for a complete ladder cable tray system.

12. Class Designation: Comply with NEMA VE 1,
13. Splicing Assemblies: Bolted type using serrated flange locknuts.
14. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33orASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

d. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Hardware: Chromium-zinc plated, ASTM F 1136.

e. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.04 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Wiremaid Products Corp.
2. Cablofil; Legrand North America, LLC.
3. Eaton (B-line).

B. Description:
1. Cable trays shall be classified by UL and rated as an equipment grounding conductor.
2. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
3. Width: 18 inches unless otherwise indicated on Drawings.
4. Minimum Usable Load Depth: 4 inches.
5. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
6. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.

a. Load-carrying ability of fittings shall be not less than the straight tray sections.

7. Class Designation: Comply with NEMA VE 1,.
8. Splicing Assemblies: Bolted type using serrated flange locknuts.
9. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
10. Cable trays shall include splices, end plates, dropouts, expansion connectors in straight runs of 125' or longer, and support/accessory items for a complete installation.

C. Materials and Finishes:
1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33orASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

d. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Hardware: Chromium-zinc plated, ASTM F 1136.

e. Finish: Chrome oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.05 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.01 CABLE TRAY INSTALLATION

A. Cable trays shall only be installed in accessible locations and that equivalent capacity of conduit shall be used to traverse inaccessible areas along cable tray route.

B. Install cable trays according to NEMA VE 2.

C. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
1. Provide all components of the cable tray system (cable tray, turns, splices, supports, and accessories) from a single manufacturer.

D. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
1. Minimum clearance of 12" above the cable tray.
2. Leave a minimum of 12" in between cable tray and ceiling/building truss structure.
3. Leave a minimum of 3" in between ladder cable tray and the tops of equipment racks and/or cabinets.
4. Minimum clearance of 12" in between each tier of cable tray.
5. When located above an acoustical drop ceiling, leave a minimum of 3" clearance between the top of the drop ceiling tiles and the bottom of the cable tray.
6. When installed under a raised floor, cable tray shall be installed with a minimum 3" clearance between the top of the cable tray and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" clearance between cable trays wherever cable trays cross.
7. Maintain a 2' separation between ladder cable tray used for communications cables and pathways for other utilities or building services.

E. Provide non-curing, re-penetrable, intumescent firestop materials around communications cable trays or ladder racks penetrating through a fire rated wall.

F. Remove burrs and sharp edges from cable trays.

G. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

H. Fasten cable tray supports to building structure and install seismic restraints.

I. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

J. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

K. Support bus assembly to prevent twisting from eccentric loading.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Ladder cable tray:

1. Install all ladder cable tray per the manufacturer's recommended installation instructions, and as indicated in the project drawings.
2. Ladder cable tray shall be installed with side stringers facing down so that the ladder forms an inverted U-shape.
3. Ladder cable tray shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
4. Ladder cable tray splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
5. Ladder cable tray support:

    a. Every 5' or less in accordance with TIA-569-D.
    b. Within 2' of every splice and within 2' on both/all sides of every intersection.
    c. Within 2' on both sides of every change in elevation.
    d. Every 2' when attached vertically to a wall.

6. Heavy-duty splices:

    a. Recommended for 18" wide or wider ladder cable tray.
    b. Required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns.
    c. To secure all overhead turns to the overhead horizontal pathway(s).

N. Support wire-basket cable trays with trapeze hangers or wall brackets.
1. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer.
2. Support for wire-basket trays with 1/2-inch diameter threaded rods.

O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

P. Make changes in direction and elevation using manufacturer's recommended fittings.

Q. Make cable tray connections using manufacturer's recommended fittings.

R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

S. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

T. Install cable trays with minimum clearance of 12" on top and 6" on the sides and bottom from all obstructions to permit access for installing cables.

U. Cover the exposed ends of cable trays that do not terminate against a wall, the floor or the ceiling, with end caps or an end closing kit.

V. Install permanent covers, if used, after installing cable.

3.02 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

F. Verify continuity through the bonds at splices and intersections between individual cable tray sections and turns and through the bond to the telecommunications grounding busbar.

3.03 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Cables (cable bundles) will be secured to the cross members of cable runway with 3/4" wide reusable straps.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. When a single cable tray supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the cable tray. Treat each type of cable media and divided area of the cable tray separately when determining cable fill limits.

F. Use a radius drop to guide cables to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member to attach and align the radius drop in between the welded cross members of a ladder cable tray.

G. Fill Ratio:
1. Not to exceed 50%.
2. Actual cable fill for ladder cable tray that is not equipped with cable retaining posts will not exceed 2" in height.
3. The combined weight of cables within the cable tray will not exceed the stated load capacity of the cable tray as stated in the manufacturer's product specifications or load/design tables.

H. In existing construction, remove inactive or dead cables from cable trays.

3.04 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.05 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects, paint, or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

a. The installer will provide touch-up paint color-matched to the finish on the cable tray and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If

a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the cable tray system.

END OF SECTION

SECTION 27 05 43 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Metal conduit and fittings, including GRC and PVC-coated GRC.
2. Rigid nonmetallic duct.
3. Duct accessories, including rigid innerduct and fabric innerduct.
4. Precast concrete handholes.
5. Fiberglass handholes and boxes with polymer concrete cover.
6. Precast manholes.
7. Utility structure accessories.

1.03 DEFINITIONS

A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:
1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid conduit.

E. IMC: Intermediate metal conduit.

F. RNC: Rigid nonmetallic conduit.

G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
3. Include accessories for manholes, handholes, and boxes, and other utility structures.
4. Include underground-line warning tape.

B. Shop Drawings:
1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including location and duct size.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include grounding details.
f. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
g. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including location and duct size.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

C. Sustainable Design Submittals:
1. Product Data: For adhesives and sealants, indicating VOC content.
2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.05 INFORMATIONAL SUBMITTALS

A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

D. Source quality-control reports.

1.06 FIELD CONDITIONS

A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of communications service.
2. Do not proceed with interruption of communications service without Owner's written permission.

B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Manufacturers: Subject to compliance with requirements, undefined:
1. Appleton - O-Z/Gedney; Emerson Electric Co., Automation Solutions.
2. Atkore International (Allied Tube & Conduit).
3. Southwire Company.

C. General Requirements for Metal Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

2.02 RIGID NONMETALLIC DUCTS

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Underground Plastic Utilities Direct Burial: RNC, complying with NEMA TC 6 & 8 and with ASTM F-512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

C. Manufacturers: Subject to compliance with requirements, undefined:
   1. Carlon.
   2. Dura-Line.
   3. Lamson & Sessions.

D. General Requirements for Nonmetallic Ducts and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
   2. Comply with TIA-569-C and TIA-758-C.

E. Solvents and Adhesives: As recommended by duct manufacturer.
   1. VOC Content: 510 g/L or less for PVC conduit and fittings.

2.03 DUCT ACCESSORIES

A. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape and tracer wire.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Maxcell.
   2. Standard Outdoor Textile Innerduct: Micro, 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250 lb polyester flat woven pull tape.
   3. Each innerduct shall be installed with unique color striping, and multi-colored pull tapes.
   4. Measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.
   5. Fabric Innerduct Fittings:
      a. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration.
      b. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.
   6. Install two 3" 3-cell fabric innerducts on one service entrance conduit. Install per manufacturer instructions.
   7. Standard 1.25” innerduct. Install (3) per 4” conduit

B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Atkore International (Allied Tube & Conduit).
      b. Cantex Inc.
      c. Carlon; a brand of Thomas & Betts Corporation.

C. Underground-Line Warning Tape: Underground-line warning tape specified in Section 27 05 53 "Identification for Communications Systems."

2.04 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Monolithically poured, factory-fabricated, reinforced-concrete walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Christy Concrete Products.
   2. Oldcastle Precast, Inc.
   3. Utility Concrete Products, LLC.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, " COMMUNICATIONS."

G. Configuration: Units shall be designed for flush burial and have closed bottom unless otherwise indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure, and made of same material as enclosure.
   1. Extension shall provide increased depth of 12 inches.
   2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches vertically and horizontally to accommodate alignment variations.
   1. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   2. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   3. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   4. Knockout panels shall be 1-1/2 to 2 inches thick.

K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   1. Type and size shall match fittings to duct or conduit to be terminated.
   2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.05 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Christy Concrete Products.
   2. Oldcastle Enclosure Solutions.
   3. Quazite; Hubbell Incorporated, Power Systems.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, " COMMUNICATIONS."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.06 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Christy Concrete Products.
2. Oldcastle Precast, Inc.
3. Utility Concrete Products, LLC.

C. Standard: Comply with ASTM C 858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct and duct banks, plus an additional 6 inches vertically and horizontally to accommodate alignment variations.
1. Splayed location.
2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
4. Knockout panel openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

G. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct routed from the facility.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.07 UTILITY STRUCTURE ACCESSORIES

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Christy Concrete Products.
2. Oldcastle Precast, Inc.
3. Quazite; Hubbell Incorporated, Power Systems.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B, with milled cover-to-frame bearing surfaces; 36" diameter.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.
3. Manhole Chimney Components: Precast concrete rings, with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities of less than 2.0 cu. ft., where packaged mix complying with ASTM C 387, Type M, may be used.
b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to a minimum of 1-1/4 inches at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Ground Rod Sleeve: 3-inch, PVC duct sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of nine holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in

lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Fixed Manhole Ladders: Arranged for attachment to wall or floor of manhole. Ladder, mounting brackets, and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

2.08 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 31 10 00 "Site Clearing."

3.02 UNDERGROUND DUCT APPLICATION

A. Duct for Communications: Type EPC-40-PVC RNC, in concrete-encased duct bank unless otherwise indicated.

B. Underground Duct Crossing Roadways : Type EPC-40-PVC RNC, encased in reinforced concrete.

C. Stub-Ups for Communications: Concrete-encased GRC.

3.03 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for Communications:
1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 High-density plastic, SCTE 77, Tier 15 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-5 Precast concrete, AASHTO HB 17, H-10 Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only:, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
1. Determine exact location of existing underground utilities before excavation.
2. Excavation shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
3. Compact backfill as the excavation is filled.

B. Restoration: Replace area immediately after backfilling is completed or after construction in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 "Turf and Grasses" and Section 32 93 00 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 01 73 00 "Execution."

3.05 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.

C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet, both horizontally and vertically, at other locations unless otherwise indicated.
1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch.
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to terminator spacing 10 feet from the terminator without reducing duct slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.

L. Pulling Cord: Install 200-lbf- test nylon cord in empty duct and innerduct.

M. Concrete-Encased Duct and Duct Bank:
   1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes less than 6 inches in nominal diameter.
   2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
   3. Width: Excavate trench 3 inches wider than duct or duct bank on each side.
   4. Depth: Install top of duct and duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
   5. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
   6. Minimum Space Between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
   7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
   8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
b. Stub-Ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups shall be minimum 4 inches abovefinished floor and minimum 3 inchesfrom conduit side to edge of slab

c. Stub-Ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups shall be minimum 4 inches abovefinished floor and no less than 3 inchesfrom conduit side to edge of wall

9. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
10. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.
12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

N. Direct-Buried Duct and Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for duct less than 6 inches in nominal diameter.
2. Install duct with a minimum of 3 inches between duct for like services and 6 inches between power and signal duct.
3. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
4. Width: Excavate trench 3 inches wider than duct or duct bank on each side.
5. Depth: Install top of duct or duct bank at least 36 inches below finished grade unless otherwise indicated.
6. Set elevation of bottom of duct or duct bank below frost line.

7. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
8. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. Extend encasement minimum of 36 inches beyond elbow joints.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.

    a. Place minimum of 3 inches of sand as a bed for duct and duct bank. Place sand to a minimum of 6 inches above top level of duct and duct bank.
    b. Place minimum of 6 inches of engineered fill above concrete encasement of duct bank.

O. Underground-Line Warning Tape: Bury underground-line warning tape specified in Section 27 05 53 "Identification for Communication Systems" no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing." After duct has been connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.

3.07 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line. below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
1. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.08 INSTALLATION OF INNERDUCT

A. General:
1. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
2. Select approved innerduct suitable for specific installation environments.

B. Textile Innerduct Installation:
1. Provide in conduit and wire ways using continuous unspliced lengths between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
2. Provide suitable standard innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
3. standard Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.

a. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
b. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires.
c. Secure textile innerduct using conventional plastic cable ties.

4. Maintenance Hole and Hand Hole Installation:

a. At locations where /standard innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
b. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

C. Penetrations:
1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.

3.09 GROUNDING

A. Ground underground duct, duct bank, and utility structures according to Section 27 05 26 "Grounding and Bonding for Communications Systems."

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.

B. Clean internal surfaces of manholes, including sump.
1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION

SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Round sleeves.
   2. Firestopping
   3. Firestopped Sleeve Assemblies

B. Related Requirements:
   1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

A. Wall Sleeves, Steel:
   1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.02 Firestopping

A. Description: Firestops shall consist of an asbestos-free fill material, forming/backing/damming materials, and accessories needed to complete a UL classified through-penetration firestopping system. Fill material shall not slump or sag and shall be the required thickness in the fully cured state.

B. Firestops shall be designed to seal through-penetrations against flame, heat, smoke, and water in compliance with ASTM E84-2016, ASTM E119-2016a, ASTM E814-2013a, and UL 723-2008.

C. Firestops shall be specifically designed and rated for the individual application, including movement, materials, moisture, penetrating item material, and fire and smoke ratings of the penetrated construction.

2.03 FIRESTOPPED SLEEVE ASSEMBLIES

A. Description: An enclosed fire rated cable management device whenever cable bundles penetrate fire rated walls.
   1. The cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated.
   2. The cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.

B. The firestop system assembly shall be able accessible and re-installed from one side of the wall.

C. UL classified for use in wall and floor systems rated for up to 3 hours

D. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Specified Technologies, Inc. - EZ-Path
   2. Legrand – FlameStopper
   3. Hilti Speed Sleeve
   4. Abesco Fire Ltd. - Cable Transit System

PART 3 - EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors a minimum of 2-inches above finished floor level unless otherwise noted on project drawings. Install sleeves during erection of floors.
   6. Wall sleeves shall extend 4" from each side of the walls.
   7. Openings through slabs for communications risers shall be finished with a 4" wide x 2" high curb around the opening.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for wall assemblies.
   3. Wall sleeves shall extend 4" from each side of the walls.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:
   1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
   2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.

D. Install sleeve-seal fittings in new walls and slabs as they are constructed.
   1. Provide where cables pass through walls or elevated floor slabs within communications rooms.
   2. Provide where cable trays pass through rated walls or elevated floor slabs. Install 4 sleeves at each penetration, unless otherwise noted.
   3. Install associated rating information decal on both sides of sleeve. Sign and date the decal.
   4. Install sleeve systems with flanges and fire-rated caulk as recommended by the manufacturer.

E. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

F. Using grout, seal the space around outside of sleeve-seal fittings.

3.03 Firestopping

A. Close and firestop abandoned penetrations and penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction’s fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases.

B. Install after installation of raceways and cable trays.

3.04 Firestopped Sleeve Assemblies

A. Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.

B. Comply with manufacturer’s instructions for installation of firestopping products.

END OF SECTION

SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Underground-line warning tape.
2. Signs.
3. Bands and tubes.
4. Cable ties.
5. Miscellaneous identification products.
6. Labels.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule:
1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. The labeling scheme is intended to comply with the ANSI/TIA-606-C and the owner’s standard for labeling and administration of a cable plant. It is the responsibility of the contractor to acquire, understand, and utilize the owner’s labeling scheme for all components of the voice data communications system. The final labeling scheme and all other label requirements shall be coordinated and confirmed with the Owner and Engineer.

2.02 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels: Brown surface with white core (lettering)

2.03 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation.
b. HellermannTyton.
c. Panduit Corp.

B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Brady Corporation.
      b. Newell Brands (DYMO).
      c. Panduit Corp.
   2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   3. Marker for Labels:
      a. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Brady Corporation.
      b. Newell Brands (DYMO).
      c. Panduit Corp.
   2. Minimum Nominal Size:
      a. 1-1/2 by 6 inches for raceway and conductors.
      b. 3-1/2 by 5 inches for equipment.
      c. As required by authorities having jurisdiction.

2.04 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Brady Corporation.
   2. Ideal Industries, Inc.

B. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

C. Color and Printing:
   1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
   2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE.

D. Tag, Detectable, Reinforced:
   1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   2. Width: 3 inches.

3. Overall Thickness: 8 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 34 lb/1000 sq. ft.
6. Tensile according to ASTM D882: 300 lbf and 12,500 psi.

2.05 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Emedco.
   d. Marking Services, Inc.

2. Engraved legend.
3. Thickness:

   a. For signs up to 20 sq. in., minimum 1/16 inch thick.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Self-adhesive.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

4. Engraved signs are to be secured on all equipment racks, cabinets and enclosures per the project requirements.
5. Font size shall be a minimum of 1"

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

PART 3 - EXECUTION

3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Self-Adhesive Wraparound Labels:
1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

K. Underground-Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Align tape parallel to and within 3 inches of centerline of duct bank.
3. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
4. Install underground-line warning tape for direct-buried cables and cables in raceways.

3.03 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
1. Wiring closet designation.
2. Colon.
3. Faceplate number.

D. Equipment Room Labeling:
1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.

    a. Rack labels shall be at least 1.5"H. Label shall be plastic or vinyl and adhered to the upper right corner of the rack, where possible.

2. Patch Panels: refer to project drawings.
3. Data Outlets: Unless otherwise noted on project drawings label each outlet with a self-adhesive label indicating the following, in the order listed:

    a. Room number being served.
    b. Colon.
    c. Faceplate number.

E. Backbone Cables: Label each cable with a vinyl-wraparound label self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

F. Horizontal Cables: Label each cable with a vinyl-wraparound label self-adhesive wraparound label indicating the following, in the order listed:
1. Room number.
2. Colon.
3. Faceplate number.

G. Grounding Equipment: Refer to Section 27 05 26, "Grounding and Bonding for Communications Systems."

H. Termination Hardware: Refer to Section 27 15 13 "Communications Copper Horizontal Cabling."

I. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

J. Instructional Signs: Self-adhesive labels.

K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
1. Apply to exterior of door, cover, or other access.

L. Equipment and Raceway Identification Labels:
1. Indoor Equipment: Self-adhesive label Laminated-acrylic or melamine-plastic sign.
2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
3. Equipment to Be Labeled:

    a. Communications cabinets.
    b. Equipment Racks

4. Raceway to Be Labeled:

    a. Riser conduit
    b. Service entrance conduit

END OF SECTION

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Backboards.
2. Boxes, enclosures, and cabinets.
3. Power strips.

B. Related Requirements:
1. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and accessories.
2. Section 27 13 13 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
3. Section 27 13 23 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
4. Section 27 13 33 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
5. Section 27 15 13 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
6. Section 27 15 33 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.03 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, AC grade void free.

B. Backboard Paint: White fire-retardant paint.

C. Do not paint over the fire rating stamp.

D. Mounting: Anchor with 3/8" toggle bolts or concrete anchors and 2" washers on each corner and 4' on center as required on all walls.

2.03 BOXES, ENCLOSURES, AND CABINETS

A. Comply with requirements in Section 27 11 16 "Communications Racks, Frames, and Enclosures."

2.04 POWER STRIPS

A. Comply with requirements in Section 27 11 16 "Communications Racks, Frames, and Enclosures."

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Comply with the latest edition of BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with the latest edition of BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:
1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. If the stamp is painted-over, the contractor shall be required to replace and properly repaint the plywood.
4. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.03 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

3.05 CLEANING

A. Remove dust, dirt, rust, stains, and temporary covers.

B. Foreign matter shall be blown, vacuumed, or cleaned out of and from new equipment, devices, switches, controls, and panels.

C. Clean and polish identification plates.

D. In equipment rooms, clean equipment, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of final acceptance until final completion of work and corrective work.

E. Remove all excess material from the Project site.

END OF SECTION

SECTION 27 11 16 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. 19-inch equipment racks.
2. Power strips.
3. Grounding.
4. Labeling.

B. Related Requirements:
1. Section 27 11 10 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 27 05 26 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
3. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.
4. Section 27 13 13 "Communications Copper Backbone Cabling" for copper data cabling associated with system panels and devices.
5. Section 27 13 23 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
6. Section 27 13 33 "Communications Coaxial Backbone Cabling" for coaxial data cabling associated with system panels and devices.
7. Section 27 15 13 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
8. Section 27 15 33 "Communications Coaxial Horizontal Cabling" for coaxial data cabling associated with system panels and devices.

1.03 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL listed.

C. RoHS compliant.

D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.02 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 10 00 "Rough Carpentry."

B. Comply with requirements in Section 27 11 00 "Communications Equipment Room Fittings."

2.03 19-INCH EQUIPMENT RACKS

A. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E,19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. 2-Post Rack: Hubbell Part #HPW84RR19

2. 6”-wide Vertical Wire Managers on ends of rack rows and max 40% fill: Panduit Part # PR2VD06
3. 2U Horizontal Wire Manager: Panduit Part #CMPHH2
4. Rear Horizontal Cable Management Bar: Hubbell #ECMBR3
5. Mounting Screws: Panduit #WMPHF2E

C. General Requirements:
1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:
1. Overall Height: 84".
2. Upright Depth: 3 inches.
3. Two-Post Load Rating: 400 lb.
4. Four-Post Load Rating: 2000 lb.
5. Number of Rack Units per Rack: 45.

a. Numbering: Every rack units, on interior of rack.

6. Threads: 12-24.
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

E. Cable Management:
1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.04 POWER STRIPS

A. Power Strips: Comply with UL 1363.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Wiremold (Legrand) - Part #R5BZ20-15.

B. Horizontal Surge-Protected Power Strips
1. Input Plug: NEMA 5-20P.
2. Input Cord Length: 15 feet.
3. Output: (6) NEMA 5-20R.
4. Metered: LED Display indicating Voltage and Amps.
5. Provide one horizontal power strip for each wall-mount rack and/or cabinet.

2.05 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
   1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
   2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
   3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.06 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Furnish and install a horizontal cable manager below each patch panel in the Rack. Refer to Project Drawings for size of Wire Managers. Horizontal cable managers are not required below angled patch panels.

H. Outdoor enclosures to be provided with ventilation according to equipment manufacturer's recommendations.

3.02 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
   1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.03 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

END OF SECTION

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. High-count Category 5e twisted pair cable.
2. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
3. Cabling identification.
4. Source quality control requirements for twisted pair cable.

1.03 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. F/FTP: Overall foil screened cable with foil screened twisted pair.

D. FTP: Shielded twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. S/FTP: Overall braid screened cable with foil screened twisted pair.

M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.04 COPPER BACKBONE CABLING DESCRIPTION

A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration Drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system
e. Cross-connects.
f. Patch panels.
g. Patch cords.

4. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:
1. Product Data: For each conductor and cable indicating lead content of less than 300 parts per million.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Contractor to submit all cable test results and any test documentation required prior to acceptance by the Owner.

C. Subsequent to the installation, and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in Adobe PDF and AutoCAD format, that reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where it varies from the original plan.

D. Provide cable termination schedules for all cables installed under the Work. Schedules shall be in printed form and on CD in Microsoft Excel format.

E. Provide Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals within fifteen days of systems acceptance.

F. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Connecting Blocks: One of each type.
2. Patch-Panel Units: One of each type.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-C.

2.02 BUILDING ENTRANCE TERMINALS

A. 16 AWG powder coated steel building entrance terminals.

B. Industry standard 110-Style Connector for both input and output terminals.

C. Connectors shall accept up to 22 AWG wire terminations.

D. Multiple external and internal ground lugs.

E. Stackable to allow for future expansion.

F. Equipped with internal fuse link.

G. UL497 approved.

H. Accommodates industry standard 5 Pin Protection Modules.

I. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Circa Telecom.
2. ITW Linx.
3. CommScope.
4. Vertiv.

2.03 GENERAL INDOOR CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
2. Communications, Riser Rated: Type CMR complying with UL 1666.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

D. PVC sheath shall have improved frictional properties, allowing it to be pulled through conduit without the use of lubricants.

2.04 GENERAL OUTDOOR CABLE CHARACTERISTICS

A. Copper cables (multipair) shall consist of solid copper conductors complying to RUS Specification PE-89 for use in underground conduit.

B. Conductors: solid, annealed copper, 24 AWG unless noted on design documents.

C. Insulation: Dual insulated with inner layer of foamed natural polyolefin covered by an outer layer of solid color polyolefin, color coded to industry standards.

D. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk. Standard capacitance of 83 to 87 Nano farads per mile and a staggered twist design.

E. Core Assembly: cables of 25 pairs and less formed by assembling pairs together in a single group. Cables of more than 25 pairs formed by twisted pairs arranged in groups with each group having a color coded unit binder.

F. Filling Compound: core assembly completely filled with an 80 degree Celsius rated ETPR compound, filling the interstices between the pairs and under the core tape.

G. Shield:
   1. Inner shield: corrugated, copolymer coated, 8 mil aluminum tape applied longitudinally without an overlap. The sheath interfaces contain an adhesive water blocking compound.
   2. Outer shield: corrugated, copolymer coated, 6 mil steel tape applied directly over the aluminum and overlays. The shield interfaces contain an adhesive compound to provide a moisture barrier.

H. Jacket: black, linear low density polyethylene.

2.05 HIGH-COUNT CATEGORY 5e TWISTED PAIR CABLE

A. Description: Balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 16MHz.

B. Cables shall be provided in the form of 25-pair or as indicated on the project drawings.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Belden, Inc.
   2. General Cable Technologies Corporation.
   3. Superior Essex International LP.

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

F. Shielding/Screening: Unshielded balanced twisted pairs (UTP).

G. Cable Rating: Plenum.

2.06 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. CommScope, Inc.
   2. Panduit Corp.

3. Siemon Co. (The).

C. General Requirements for Cable Connecting Hardware:
1. Twisted pair cable hardware shall meet the performance requirements of Category-5e.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Connecting Blocks: 66-Style IDC. Provide blocks for the number of cables terminated on the block, plus 25 percent spare.
1. Termination blocks shall be Category 3 component level compliant, and shall facilitate cross-connection and interconnection using cross-connect wire (voice only).
2. Termination blocks shall be fire retardant, molded plastic with 89D mounting bracket.
3. Terminating blocks shall be in 50-pair form (4 columns of IDC connectors). Termination blocks shall be able to accommodate #24 AWG conductors. Terminating blocks shall be UL listed.

2.07 CABLING IDENTIFICATION

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

2.08 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

B. Provide lightning protectors and grounding conductors for the equipment and exposed incoming cable. Exposed cable shall be as defined in the BICSI Telecommunications Distribution Methods Manual.

C. For small pair count applications, provide electrical protection devices consisting of mounting panel for a series of balanced solid-state protector units and a wiring block and the protector units. Wiring blocks shall be used for input and output cable terminations. Insertion of the protector units into the mounting block shall complete the circuit. For 50-pair count and greater, provide protector panels and circuit protector modules.

3.02 WIRING METHODS

A. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.03 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings."

B. Comply with Section 27 05 28 "Pathways for Communications Systems."

C. Comply with Section 27 05 29 "Hangers and Supports for Communications Systems."

D. Comply with Section 27 05 36 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.04 INSTALLATION OF COPPER BACKBONE CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
12. Run riser cables in a star topology, terminated in the main equipment room at one end and in the communications room at the other end unless otherwise indicated on the Drawings.
13. Observe the bending radius and pulling strength requirements of backbone cables during handling and installation.
14. At a minimum, provide a 15’ maintenance coil at the origin and destination of each copper backbone cable. Each maintenance loops shall be neatly organized, mounted and labeled on the plywood backboard.
15. Install cable runway vertically from floor to ceiling in communications closets to support vertical cables. Strap cables to runways 3' on center.
16. Provide distribution rings to support cable vertically and horizontally on plywood backboards. Install D-rings 12" on center.
17. Provide Velcro around cables to manage and support cable located 12" on center.
18. If terminating a 25 or 50-pair cable (or 25-pair binder group of a larger pair-count cable) to a 24 or 48 port patch panel, the last pair (violet/slate) shall be coiled unterminated at the rear of the patch panel.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.05 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."
    1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 27 15 13 "Communications Copper Horizontal Cabling" for cable and asset management software.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented.
1. The test results/measurements shall be submitted in both the test equipment manufacturer’s raw data file and searchable PDF format files.
2. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered in digital format prior to Owner acceptance of the building. This digital format shall include the software tools required to view, inspect, and print any selection of the test reports.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. A representative of the Owner may elect to test 5% of the installed cables. The test results will be compared with the submitted results. In the event that more than 2% of the compared results

differ from the submitted results, the Owner may contract with a third-party testing firm to retest 100% of the installation and the cost shall be borne by the Contractor.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. 9/125 micrometer single-mode, inside plant optical fiber cable (OS2).
2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
3. Cabling identification products.

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.04 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Cross-connects.
    f. Patch panels.
    g. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Optical fiber cable testing plan.

D. Sustainable Design Submittals:
1. Product Data: For each conductor and cable indicating lead content.
2. Environmental Product Declaration: For each product.
3. Health Product Declaration: For each product.

4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Product Certificates: For each type of product.

D. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

B. Contractor to submit all cable test results and any test documentation required prior to acceptance by the Owner.

C. Subsequent to the installation, and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in Adobe PDF and AutoCAD format, that reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where it varies from the original plan.

D. Provide cable termination schedules for all cables installed under the Work. Schedules shall be in printed form and on CD in Microsoft Excel format.

E. Provide Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals within fifteen days of systems acceptance.

F. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.02 9/125 MICROMETER, SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered, optical fiber cable. Number of strands as indicated on project drawings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Corning Cable Systems.

a. 24-Strand Singlemode Riser Cable: Part #024E88-33131-29

C. Standards:
1. Comply with TIA-492CAAA for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-83-596 for mechanical properties.

D. Conductive cable shall be aluminum armored type.

E. Maximum Attenuation: 0.4 dB/km at 1310 nm; 0.3 dB/km at 1550 nm.

F. Jacket:
1. Jacket Color: Yellow.
2. Type: Unarmored.
3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
4. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
2. Riser Rated, Nonconductive: Type OFNR [**or**], complying with UL 1666.

2.03 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Corning Cable Systems.

a. Fiber Enclosure: Part #PCH-01U, PCH-02U or PCH-04U as indicated on the project drawings.
b. Singlemode Connector Panel: Part #CCH-CP12-A9

c. Singlemode Unicam Connectors: Part #95-200-99

B. Standards:
1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Fiber Optic Enclosure
1. Shall provide cross connect, interconnect, and splicing capabilities and contain troughs for supporting and routing of the fiber cables and jumpers.
2. Shall consist of a modular enclosure with retainer rings in the slack storage section to limit the bending radius of fibers.
3. Shall have a window section to insert connector panels for mounting of connectorized fibers.
4. Shall provide capacity to accommodate quantity of terminations as indicated on the project drawings, plus 25% spare capacity for future growth.
5. Refer to Project Drawings for Wall-Mount and Rack-Mount requirements.

D. Fiber Connector Panels
1. Modular, quick-fastening steel plate, powder-coated to match the fiber enclosure finish.
2. Shall have a pre-installed array of fiber adapters of a specific connector type, available in low- or high-density versions.
3. Pre-installed, push-pull type quick-release fasteners for quick snap-in installation.
4. Suitable for mounting either vertically or horizontally.
5. Panels with SC or LC adapters shall have precision phosphor-bronze alignment sleeves that are suitable for either singlemode or multimode transmission. SC/APC adapters shall have precision ceramic alignment sleeves.
6. All fiber panels shall have dust caps installed.

E. Fiber Optic Connectors
1. Field Polish Connectors

a. LC small form factor (SFF) field polish connectors with rear pivot latch are TIA-604 FOCIS-10 compatible. LC simplex and duplex connectors are field terminable. The fibers shall terminate in 1.25mm ceramic ferrules with non-optical disconnect functionality and an average insertion loss of 0.1dB per mated pair for multimode and singlemode fiber.

2. Connector Pigtails

a. Optical fiber pigtails shall be constructed with a fiber connector, factory terminated onto a cut length of 900 micron buffered fiber cable of specific color.
b. Connector pigtail terminations shall be heat-cured epoxy type with a machine polish, inspected 100% for polish quality and mated-pair insertion loss.
c. Epoxy volume within each connector shall be sufficient to properly surround and strain relieve the buffer layer at the buffer/fiber transition inside the connector body.
d. Pigtails shall be available in standard lengths of 3 meters.
e. Connector shall be LC-Style complying with TIA-604-10-B.
f. Factory terminated connectors shall comply with the applicable ANSI/TIA-604 Intermateability standard.

F. Splices and Closures
1. The fiber splice module shall be utilized for all outside plant terminations. The link shall consist of the fiber cable, the splice, the splice tray holder/closure, the fiber panel/coupler, a pre-manufactured fiber pigtail with pre-polished fiber connector, and a fiber jumper to connect the pigtail-coupled link to the appropriate electronic switch. The fiber splice module shall meet the following specifications:

a. Fusion: Optical fiber splices shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/TIA-455-34, Method A (factory testing) or ANSI/TIA-455-59 (field testing). Optical fiber splices shall have a minimum return loss of 20 dB for multimode, 26 dB for single mode, when measured in accordance with ANSI/TIA-455-107. The minimum single mode return loss for broadband analog video (CATV) applications is 55 dB.
b. All fusion splices shall be mounted in protective trays within the closure.
c. Joins single mode or multi-mode fibers.
d. Establishes a permanent fusion splice.
e. May be used in OSP and/or premises applications.
f. Accept 250 and 900 micron fibers.
g. Re-enterable, portable and reusable.
h. Require no polishing.
i. Require no adhesives.
j. No loose parts.
k. Unlimited shelf life.

G. Patch Cords: Factory-made, dual-fiber cables in lengths.
1. The fiber optic patch cord will be consistent with termination type and fiber optic mode. (i.e., singlemode or multimode).
2. Field terminated patch cords are not acceptable.

2.04 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-C.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

2.06 SOURCE QUALITY CONTROL

A. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

B. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

A. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:
1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."

3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
5. Install plenum rated cables where cables are not installed in conduits or enclosed wireways.
6. Install cables designed for the installation environment.

    a. For each cable distribution application, install fiber optic cables UL listed for the application.
    b. For cable distribution applications including enclosures or raceways underground or in slabs on grade, install fiber optic cables designed for use in wet locations.

7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
14. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
15. Place fiber-optic cable so as to maintain the minimum cable bend radius limits specified by the manufacturer.
16. Place fiber-optic cables transitioning between the cable trays and cabinets or racks in a neat and orderly manner per NEC 318.11(b) requirements and pathway requirements of TIA 569-A. Velcro transitioning bundles.
17. Secure the cables in the Communication Rooms with cable ties or straps as needed to prevent cables from sagging or becoming disorderly.
18. Follow manufacturer’s installation instructions for connector installation.
19. Bring fiber optic cables into patch panels or cabinets at one location. Secure cables inside patch panels or cabinets at entrance points by securing fiber jackets. Break out individual fiber cables inside of panel or cabinet.
20. Fusion splices shall be located in attached splice trays.
21. Follow guidance of ANSI/TIA-568-C.3 regarding polarity management of fiber elements in the permanent link. Directly terminate fiber-optic on patch panels, in standard color code order.
22. Use connector manufacturer’s recommended tools.
23. Fiber-optic connecting hardware and material including patch panels, connectors, cross-connect cables, patch cords, and other components used to connect fiber-optic cable shall be sourced from the same manufacturer.
24. Non-Armored Fiber cables shall be installed in innerduct.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.04 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.05 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
1. Flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated by the manufacturer within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
c. Test equipment and modules shall be within the calibration period recommended by the manufacturer of the test equipment in order to achieve the manufacturer-specified measurement accuracy, and shall be within 1 year of the test date.
d. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
2) Single-mode backbone links shall be tested bidirectionally at both 1310 nm and 1550 nm in accordance with TIA 526-7A-2015, Method A.1, One Reference Jumper. Single-mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.
3) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

e. Cable test results with negative loss values shall be deemed invalid. Fiber terminations shall be cleaned, evaluated, and retested until the results contain no negative loss values at no additional cost to the Owner. Verify that the cable test results are valid.

4. Optical Time Domain Reflectometer (OTDR) Tests:

a. Perform OTDR testing on outside-plant fiber.
b. OTDR testing shall meet the following requirements for both single-mode and multimode fiber cabling:

1) Reflective events (connections) shall not exceed 0.5 dB.
2) Non-reflective events (splices) shall not exceed 0.15 dB.
3) Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
4) Each fiber link and channel shall be tested in both directions.

a) Multimode: 850 nm and 1300 nm.
b) Single-mode: 1310 nm and 1550 nm.

5) A launch cable shall be installed between the OTDR and the first link connection.
6) A receive cable shall be installed after the last link connection.
7) The length of each fiber shall be recorded.

C. Data for each measurement shall be documented.
1. The test results/measurements shall be submitted in both the test equipment manufacturer's raw data file and searchable PDF format files.
2. The database for the complete project shall be stored and delivered in digital format prior to Owner acceptance of the building. This digital format shall include the software tools required to view, inspect, and print any selection of the test reports.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. A representative of the Owner may elect to test 5% of the installed cables. The test results will be compared with the submitted results. In the event that more than 2% of the compared results differ from the submitted results, the Owner may contract with a third-party testing firm to retest 100% of the installation and the cost shall be borne by the Contractor.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 27 13 33 - COMMUNICATIONS COAXIAL BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. CATV coaxial cable.
2. Coaxial cable hardware.
3. Grounding.
4. Identification products.

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

1.04 COAXIAL BACKBONE CABLING DESCRIPTION

A. Coaxial cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test each coaxial cable on the reel for continuity.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-D.

2.02 GENERAL CABLE CHARACTERISTICS

A. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
1. CATV Plenum Rated: Type CATVP installed in riser raceways or cable routing assemblies, complying with NFPA 262.

2.03 CATV COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.
1. .500 Trunk Cable

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. CommScope, Inc.

a. Part #: P3-500 JCAR

2.04 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-D.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.03 INSTALLATION OF PATHWAYS

A. Comply with requirements specified in Section 27 11 00 "Communications Equipment Room Fittings." Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for installation of conduits and wireways.

B. Drawings indicate general arrangement of pathways and fittings.

C. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Communications Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 4" above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.04 INSTALLATION OF COAXIAL BACKBONE CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

8. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:
1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.05 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-D and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

B. Tests and Inspections:
1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Category 6a twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Multiuser telecommunications outlet assembly.
4. Cabling identification products.
5. Source quality control requirements for twisted pair cable.

1.03 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.04 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   3. Cabling administration Drawings and printouts.
   4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.
      g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:
   1. Product Data: For each conductor and cable indicating lead content.
   2. Environmental Product Declaration: For each product.
   3. Health Product Declaration: For each product.
   4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

E. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration and faceplates for color selection and evaluation of technical features.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

E. Authorized to provide manufacturer's system warranty per 1.9B.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Contractor to submit all cable test results and any test documentation required prior to acceptance by the Owner.

C. Subsequent to the installation, and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in Adobe PDF and AutoCAD format, that reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where it varies from the original plan.

D. Provide cable termination schedules for all cables installed under the Work. Schedules shall be in printed form and on CD in Microsoft Excel format.

E. Provide Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals within fifteen days of systems acceptance.

F. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faceplates: One of each type.
   2. Jacks: Ten of each type.
   3. Multiuser Telecommunications Outlet Assemblies: One of each type.
   4. Patch-Panel Units: One of each type.
   5. Plugs: Ten of each type.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Manufactures system Warranties, minimum 25 year term:

   1. Hubbell Mission Critical for Hubbell hardware
   2. nCompass or 25-year program for Legrand (Ortronics) and Superior Essex
   3. Leviton Network Solutions Warranty for Leviton and BerkTek

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-D.

2.02 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
   2. Communications, Non-plenum: Type CMR complying with UL 1666.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

D. Cable Construction
1. Listed CMR cable: Solid copper conductors with high-density polyolefin insulation and an overall low smoke polyvinyl chloride (PVC) jacket to achieve a riser (i.e., non-plenum) rating by applicable NEC requirements.
2. Listed CMP cable: Solid copper conductors with fluorinated ethylene propylene (FEP)/polyolefin insulation and an overall low smoke PVC jacket to achieve plenum rating by applicable NEC requirements.
3. OSP outdoor cable rated for wet locations: Solid copper conductors with polyolefin insulation, polyolefin fluted center member with flooding compound, and black polyethylene jacket.

E. Minimum compliant cables are not acceptable.

F. Copper Clad Aluminum cables are not acceptable.

2.03 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Berk-Tek Leviton; a Nexans/Leviton alliance.

a. LANMark-XTP Category-6A

1) CMP reel in box part number: 11101255
2) CMP reel only part number: 11082058
3) CMR reel in box part number: 11101258
4) CMR reel only part number: 11082063

2. Hubbell

a. NEXTSPEED Ascent Category-6A

1) CMP reel in box part number: C6ASPDSW
2) CMP reel only part number: C6ASPPDSW
3) CMR reel in box part number: C6ASRDSW
4) CMR reel only part number: C6ASPRDSW

3. Superior Essex Inc.

a. 10Gain XP Category 6A

1) CMP reel in box part number: 6H-246-4B
2) CMP reel only part number: 6H-272-4B
3) CMR reel in box part number: 6H-246-4A
4) CMR reel only part number: 6H-272-4A

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket: color as indicated on project drawings; thermoplastic.

2.04 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Hubbell- Hubbell product set may be paired with any cable specified in 2.3.B
      a. Patch Panel: Part #UDX48E1U
      b. Faceplate: Part #IFP160W
      c. Blank Insert: Part #SFB10 (Office White)
      d. Data Jack: Part #HJU6AR
      e. Data Jack Dust Covers: Part #HXJDC25

   2. Leviton- Leviton product to be paired only with BerkTek Cable specified in 2.3.B.1

      a. Patch Panel: Part # 49255-Q48
      b. Faceplate: Part # 42080-6WS
      c. Blank Insert: Part # 41084-0BW
      d. Data Jack: Part # 6AUJK-RR6
      e. Data Jack Dust Cover: Part # 51084-ICN

   3. Ortronics – Ortronics product set to be paired only with Superior Essex cable specified in 2.3.B.3

      a. Patch Panel: Part # SPKSU48
      b. Faceplate: Part # KSFP6
      c. Blank Insert: Part # KSB10
      d. Data Jack: Part # KT2J6A-42
      e. Data Jack Dust cover: Part # 20309155

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6a.
   2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables. Patch panels shall be rated to meet channel warranty requirements.
   1. Features:

      a. Style: Flat
      b. Unloaded type panels, 1U.
      c. Universal T568A and T568B wiring labels.
      d. Labeling areas adjacent to conductors.
      e. Replaceable connectors.
      f. 24 or 48 ports as indicated on the project drawings.
      g. Rear strain-relief bar.

   2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.

F. Modular Plug Termination Link (Direct Connect)
   1. Standard: Conform to TIA-568.2-D, Annex F
   2. Uses: Termination at end device including Wireless Access Points, CCTV Cameras, TV Displays, Projectors, and other devices as indicated on the project drawings.
   3. Do not use unless specifically indicated to do so on the Project Drawings.

G. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.
5. Refer to project drawings for locations of Cat-3, 5e, 6 and 6A Jacks.
6. Provide keystone-style jacks as required in floor boxes, poke-thru's, modular furniture adapter plates, and other locations as required.

H. Faceplate:
1. Six-port, vertical double gang faceplates designed to mount to double gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices" and with Architect.
3. Faceplates shall be designed with flush angled port openings to accept jacks and other outlets indicated on the Drawings.
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
5. Faceplates shall not extend more than 0.25" from the face of the wall.
6. Faceplates shall have an integrated label holder with clear plastic cover. Single gang faceplates shall have 2 integrated label holders with clear plastic covers; one shall be above the jacks and one shall be below the jacks. Double gang faceplates shall have 4 integrated label holders with clear plastic covers; two shall be above the jacks and two shall be below the jacks.

I. Modular Furniture Adapter Faceplates
1. Faceplates shall be designed for use within modular furniture.
2. Faceplates shall have an integrated label holder with clear plastic cover.
3. Confirm dimension of furniture knockout with proposed modular furniture adapter to ensure compatibility.
4. Color: black for dark furniture; ivory for light colored furniture.

J. Floor Box / Poke-Thru Adapter Plates
1. Coordinate with requirements of Division 26 as applicable.
2. Adapter Plates shall accept data jacks, A/V connectors, and other required connectivity devices as indicated on the drawings.

K. Surface Mount Boxes
1. 1-Port and 2-Port surface mount boxes as indicated on the project drawings.
2. Plenum rated as required.
3. Shall accept jacks from the same manufacturer as other components used throughout the project.

L. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.06 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings."

B. Comply with Section 27 05 28 "Pathways for Communications Systems."

C. Comply with Section 27 05 29 "Hangers and Supports for Communications Systems."

D. Comply with Section 27 05 36 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. Jacks shall be wired per the pair assignments indicated in the ANSI/TIA-568.1D-2015 designation T568B wiring plan.

C. General Requirements for Cabling:
   1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
   2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
   3. Horizontal cables shall be installed in a star topology from each communications outlet to the Telecommunications room serving that area.
   4. The length of each horizontal cable from the Telecommunications room to the communications outlet shall not exceed 295'. Coordinate with the conduit and cable tray installation and modify as necessary to ensure distance requirements are not exceeded.
   5. Install 110-style IDC termination hardware unless otherwise indicated.
   6. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
   7. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
   11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
   12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   13. In the communications equipment room, install a 10-foot- long service loop on each end of cable.

14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
15. Observe the bending radius and pulling strength requirements of the cables during handling and installation.
16. Provide clutch or shear pin protection for cables during cable pulling to ensure cable pulling tension is not exceeded.
17. Conceal horizontal cables within ceilings and walls.
18. Cables, when not installed in conduit or cable tray, shall be bundled in groups of no more than 50 cables for Category 5e and 6, and no more than 24 cables for Category-6A. Cable bundle quantities exceeding these limits may cause deformation of the bottom cables within the bundle and degrade cable performance. Cable raceways shall not be filled greater than the ANSI TIA-569-A maximum fill for the particular raceway type or 40%.
19. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
20. Provide temporary protection of cables before termination. Cables shall not be left lying on the floor. Bundle and use Velcro or hook and loop tape to provide protection against bundle deformity.
21. Provide a 5’-7’ service loop at the entrance of conduits that terminate at communications outlets.

D. Open-Cable Installation:
1. Complete work above ceiling prior to ceiling tile installation.
2. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
3. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
4. Cabling routed above ceilings shall be supported using the following methods:

    a. In cable tray above accessible ceiling where indicated on the Drawings.
    b. In conduit where indicated on the Drawings. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
    c. Cables shall not be attached to ceiling grid or lighting fixture wires.

5. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Communications Outlets
1. Communications outlets shall be formed from an assembly of faceplates and jacks as indicated on the Drawings.
2. Communications outlets installed in walls shall be installed in a double-gang box, with a single-gang plaster ring, terminating cables from the Telecommunications room.
3. Install outlets straight and perpendicular to walls and ceilings.
4. Secure faceplates with screws.
5. Label appropriately and cover each label with the clear plastic cover provided with the faceplate.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.05 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.06 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

C. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
4. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
5. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.

6. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

D. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified in TIA-568-C and shall have been calibrated by the manufacturer within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.

C. Data for each measurement shall be documented.
1. The test results/measurements shall be submitted in both the test equipment manufacturer’s raw data file and searchable PDF format files.
2. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered in digital format prior to Owner acceptance of the building. This digital format shall include the software tools required to view, inspect, and print any selection of the test reports.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

1. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. A representative of the Owner may elect to test 5% of the installed cables. The test results will be compared with the submitted results. In the event that more than 2% of the compared results differ from the submitted results, the Owner may contract with a third-party testing firm to retest 100% of the installation and the cost shall be borne by the Contractor.

G. Prepare test, inspection reports and any other documentation to satisfy manufacturer's extended warranty requirements. Contractor shall furnish test reports in both PDF and source data files.

END OF SECTION

SECTION 27 15 23 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. 50/125 micrometer, multimode, optical fiber cable (OM2).

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.04 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration Drawings and printouts.
4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.
g. Mechanical, electrical, and plumbing systems.

C. Fiber optic cable testing plan.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For , installation supervisor, and field inspector.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings by an Technician.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an Technician.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use .
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

2.02 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, 2 -fiber, nonconductive , tight buffer, optical fiber cable.

B. Standards:
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-492AAAB for detailed specifications.

C. Maximum Attenuation: [**3.50**] dB/km at 850 nm; [**1.5**] dB/km at 1300 nm.

D. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

E. Jacket:
   1. Jacket Color: Orange.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   2. Plenum Rated, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:
   1. Comply with TIA-568-C.1 and TIA-568-C.3.
   2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
   3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
   10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
   11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.

3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.03 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 27 40 15 - AUDIO-VISUAL INFRASTRUCTURE AND RACEWAY

PART 1 - GENERAL

1.01 DESCRIPTION

A. General provisions are specified in Section 26 00 10, Electrical General, and other Sections of Division 26.

B. This Section covers raceway and boxes to support the Audio-Visual-Systems described in other Sections and on the Drawings.

1.02 QUALITY ASSURANCE

A. Conform to all codes and standards listed in PART 1 of Section 26 00 10, Electrical General.

B. This Section includes responsibilities and obligations in support of the Performance Verification specified in Section 26 00 90, Electrical Performance Verification.

1.03 SUBMITTALS

A. General submittal requirements as identified in Section 26 00 10, Electrical General. In addition to those requirements, submittals for this Section shall include the following:
   1. Floor plans indicating box and raceway locations.
   2. Elevations of all walls where a specific dimension or spatial relationship between a box and another box, device, or building component is required.
   3. Manufacturer's submittal forms, or detail drawings when such a form is unavailable, for configurable boxes, such as multi-compartment floor boxes and poke-through devices with multiple options. The documentation submitted shall include all part numbers and options to be ordered with the configurable box.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Refer Section 26 05 44, Sleeves and Sleeve Seals for Electrical Equipment for additional requirements.

B. Wall sleeves shall be galvanized rigid metal conduit or electrical metallic tubing.

C. For floor slabs above grade, plastic core form block-outs shall be used.

2.02 PENETRATION SEALS

A. Firestops:
   1. Refer to Section 07 84 13 Penetration Firestopping.
   2. Firestops shall consist of an asbestos-free fill material, forming/backing/damming materials, and accessories needed to complete a UL classified through-penetration firestopping system. Fill material shall not slump or sag and shall be the required thickness in the fully cured state.
   3. Firestops shall be designed to seal through-penetrations against flame, heat, smoke, and water in compliance with ASTM E84-2018, ASTM E119-2018, ASTM E814-2013a (2017), and UL 723-2018.
   4. Firestops shall be specifically designed and rated for the individual application, including movement, materials, moisture, penetrating item material, and fire and smoke ratings of the penetrated construction.
   5. Manufacturer: 3M, GE, Flammadur, Hilti, Nelson, Rectorseal, Thomas & Betts.

B. Expansion Seals:
   1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
   2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, Thunderline Link Seal.

C. Seal Assemblies:

1. Seal assemblies shall consist of a frame, compression mechanism, and insert modules. Assemblies shall be waterproof and shall be designed to allow easy addition or deletion of penetrating items.
2. Seal assemblies for multicable penetrations of fire and smoke rated construction shall comply with the requirements of firestops as specified herein.
3. Manufacturer: Nelson Multi-Plug.

2.03 ACCESS PANELS – BUILDING

A. Access panels shall be flush type with concealed hinges. Frame shall be 16-gauge steel or extruded aluminum, and panel shall be 14-gauge steel. Provide flush screwdriver operated cam latches. key operated cylinder locks. Panels shall be finished for painting.

B. Minimum size of panels shall be 12" H x 12" W for handholes, 18" H x 18" W elsewhere.

C. Fire rated access panels shall be UL listed, and shall have 16-gauge steel frames, 20-gauge hollow steel door with fire resistive insulation, finished for painting, automatic closure springs, and key operated cylinder locks.

D. Panels in inaccessible acoustical tile ceilings shall be designed to accept tiles.

E. Manufacturer: Bar-Co, Cesco, J.L. Industries, Karp, Larsen's, Milcor, Nystrom.

2.04 HIGH TRAFFIC SLEVES

A. Rated for walls and above grade floor slabs.

B. A self-contained firestop system that automatically adjusts to cable load.

C. UL classified for use in wall and floor systems rated for up to 3 hours.

D. Manufacturer: Abesco Cable Transit System, Specified Technologies EZ-Path, Wiremold FlameStopper.

2.05 RACEWAY, CABLE TRAYS, AND BOXES

A. Raceways, cable trays, boxes, and related equipment shall be in accordance with applicable Division 26 Specification Sections.

B. Wall Boxes:
1. All wall boxes shall be deep, unless otherwise noted.
2. Sizing and type as indicated on the Drawings.

C. Cable Runways:
1. Cable runways shall form a wireway system for cable management inside communications rooms. Runways shall include nominal 12" wide, steel construction, with endplates and dropouts. Runways shall be classified by UL as an equipment grounding conductor.
2. Runways shall have 0.375" H x 1.5" W stringers rated for 42 lb/ft @ L/360 when supported at 6.0' intervals.

D. J-Hooks:
1. J-hooks shall be designed to support a minimum of 80 Category 6 cables, shall be steel, UL listed for a maximum static load of 50 lb, and shall be rated for use in plenum environments.

E. Audio-Visual Floor Boxes:
1. Refer to Audio-Visual Infrastructure Drawings for additional requirements.
2. Floor boxes shall be UL listed.
3. Floor boxes shall be designed for the type of floor in which they will be installed.
4. Floor boxes shall have temporary construction cover and finish cover as shown.
5. Floor boxes shall have separate UL-rated divisions (compartments) as shown on the Drawings.
6. Floor boxes shall be rated for on-grade applications where required by code.
7. Manufacturer: FSR, Hubbell, Legrand/Wiremold.

F. Recessed Flat Panel Display Mount Boxes:
1. Functionally designed to recess a flat panel display swing-arm mount assembly within a wall and provide a connection point for high-voltage and low-voltage signals.
2. UL listed.
3. Color: black.
4. Dimensions as shown on the Drawings.
5. Conduit and gang-box knockouts as shown on the Drawings.
6. Weight capacity, excluding the mount assembly: 138 lbs.
7. Manufacturer: Chief, Premier, Peerless, Ergotron, Ergomart.

G. In-Wall Audio-Visual Storage Boxes:
1. Functionally designed to provide storage space for small devices and provide a connection point for high-voltage and low-voltage signals.
2. UL listed.
3. Dimensions and construction as shown on the Drawings.
4. Integrated universal zip tie anchor points.
5. Integral receptacles and/or surge suppression devices as shown on the Drawings.
6. Color: as shown on the Drawings.
7. Conduit and gang-box knockouts as shown on the Drawings.
8. Trim ring (flange).
9. Cover as shown on the Drawings.
10. Manufacturer: Chief, FSR, Hubbell.

H. In-Ceiling Audio-Visual Storage Boxes:
1. Functionally designed to provide storage space for small devices and provide a connection point for high-voltage and low-voltage signals.
2. UL-listed.
3. Approved by the manufacturer for mounting in the ceiling type as shown on the Drawings.
4. Dimensions and construction as shown on the Drawings.
5. Integral projector mounting flange as shown on the Drawings.
6. Integral universal zip tie anchor points.
7. Integral receptacles and/or surge suppression devices as shown on the Drawings.
8. Color: as shown on the Drawings.
9. Conduit and gang-box knockouts as shown on the Drawings.
10. Trim ring (flange) as shown on the Drawings.
11. Cover as shown on the Drawings.
12. Manufacturer: Chief, FSR, Peerless.

PART 3 - EXECUTION

3.01 GENERAL

A. Unless otherwise noted, basis of design raceway identified herein or on the Drawings is in EMT trade sizes. If flexible metallic conduit is used, all conduits shall be upsized by one trade size.

3.02 SLEEVES

A. Provide where conduits pass through elevated floor slabs if conduits are not a part of the slab pour and for future cable or conduit risers.
1. Install in raised foundations at least 2.0" high.

B. Provide where cables pass through walls and elevated floor slabs.

C. Wall sleeves shall extend 4.0" from each side of the walls.

D. Openings through slabs for busway risers shall be finished with a 4.0" W x 2.0" H curb around the opening.

E. Sleeves shall be secured in place. Provide insulating bushings on both sides of sleeves for cables.

F. Provide ground bushings on both sides of sleeves containing separate ground conductors.

3.03 PENETRATION SEALS

A. General:
1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
2. Any void or openings in floor constructions or penetrations of acoustically rated walls, except as specified herein, shall be filled by packing with fiberglass and caulking both ends 1.0" deep.

B. Expansion Seals:
1. Install to seal single conduit or cable penetrations of walls below grade.

C. Seal Assemblies:
1. Install to seal the penetration of walls below grade by multiple cables in the same opening.

3.04 ACCESS PANELS – BUILDING

A. Where Audio-Visual work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.

B. Audio-Visual work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.

C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.

D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.

E. Installation of access panels is specified under another Division.

3.05 HIGH TRAFFIC SEALS

A. Where Audio-Visual work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.

B. Audio-Visual work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.

C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.

D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.

E. Installation of access panels is specified under another Division.

3.06 RACEWAYS, CABLE TRAYS, AND BOXES

A. General:
1. Install raceways, cable trays, boxes, and related equipment in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems, Section 26 05 33, Raceways and Boxes for Electrical Systems, Section 26 05 36, Cable Trays, and Section 26 05 39, Underfloor Raceways for Electrical Systems.
2. Install wiring or cables in raceways where wiring or cables are installed underground, in concrete, and concealed in walls or in inaccessible ceilings, unless otherwise specified herein.
3. Install wiring or cables in raceways where wiring or cables are otherwise exposed, including open ceiling spaces.

B. Cable Runways:
1. Provide ground straps between each section and ground the runway to the ground bus bar.

C. J-Hooks:
1. Install maximum 5.0' on center.

2. Attach J-hooks to the structure as recommended by the manufacturer, except that J-hooks shall not be installed using drop wires or ceiling support wires. J-hooks shall not be connected to ceiling supports, utilities, or equipment.

D. Recessed Flat Panel Display Mount Wall Boxes:
1. Provide trim ring (flange).
2. Install per manufacturer's instructions.
3. Provide blocking as required to support future display. Coordinate with Architect.
4. Frame around box to maintain acoustical rating of walls. Coordinate with Architect.
5. Install conduit and gang-boxes as shown on the Drawings.
6. Install per other requirements as shown on the Drawings.

E. In-Wall Audio-Visual Storage Boxes:
1. Provide trim ring (flange).
2. Install per manufacturer's instructions.
3. Frame around box to maintain acoustical rating of walls. Coordinate with Architect.
4. Install conduit and gang-boxes as shown on the Drawings.
5. Install per other requirements as shown on the Drawings.

3.07 PERFORMANCE VERIFICATION

A. Performance Verification of these systems shall be performed in conjunction with the Performance Verification requirements in Section 26 00 90, Electrical Performance Verification.

B. Performance Verification of the equipment included herein shall be conducted in accordance with requirements in other Specification Sections that cover related equipment.

END OF SECTION

SECTION 27 41 26 - PROJECTION SCREENS

PART 1 - GENERAL

1.01 DESCRIPTION

A. General Provisions are specified in Section 26 00 10, Electrical General, and other Sections of Division 26.

B. This Section covers projection screens and related equipment.

1.02 QUALITY ASSURANCE

A. Conform to all codes and standards listed herein.

B. Conform to all codes listed in PART 1 of Section 26 00 10, Electrical General.

C. Performance Verification responsibilities and obligations related to the projection screens are specified herein.

D. This Section includes responsibilities and obligations in support of the Performance Verification specified in Section 26 00 90, Electrical Performance Verification.

E. AVIXA 10-2013, Audio-Visual Systems Performance Verification.

F. AVIXA 2012, Audio-Visual Implementation Handbook.

G. ISO 9001-2015.

H. NFPA 70-2020.

I. North Carolina State Electrical Code-2018.

J. National Electrical Code-2017 with South Carolina Modifications-2020.

1.03 SUBMITTALS

A. General submittal requirements as identified in Section 26 00 10, Electrical General. In addition to those requirements, submittals for this Section shall include the following:

1. Floor Plans and/or RCPs showing the location of each projection screen and projection screen control device.
2. The projection screen manufacturer’s submittal form completed specifically for this Project. When this scope includes multiple projection screens, one submittal form shall be submitted for each screen and shall indicated the space in which that screen will be installed.
3. Drawings showing connections to suspension systems and details showing the screen’s anchoring to structure.
4. Details of juncture of exposed surfaces with adjacent finishes.
5. Submittals are required before installation or fabrication begins. The Contractor shall not procure any equipment or perform any fabrication on any portion of this scope that has not received approval as defined herein. The Contractor shall be responsible for any costs related to returning, replacing, or not using any component of this scope that is ordered, fabricated, or installed prior to receiving such approval. Pay requests will not be approved for any work performed without approved Submittals.
6. Dimensioned shop drawings of all fabricated, custom, or modified hardware, components, or devices. Provide a finish sample for all exposed finishes.

1.04 SUBMITTALS

A. Post-Award Submittal Requirements:

1. As the first requirement of this scope after receipt of notice to proceed, the Contractor shall submit:
    a. A schedule indicating the proposed submission date of each Submittal specified herein. The schedule shall anticipate the Submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping, and integration into the construction sequence. The Architect will advise of any conflicts in reviewing Submittals that the proposed schedule present.

b. A list of key personnel names and their assignment(s) related to this Project. Certification credentials shall be submitted for all personnel who were not identified in the bid package or who have had new or renewed certification since the Project was awarded.

B. Pre-Installation Submittal (Shop Submittal) Requirements:

1. Partial Submittals may be acceptable. The Contractor shall notify the Architect in writing to request approval to submit partial Submittals. The Architect will indicate whether partial Submittals will be accepted or not. Any approval granted on a partial Submittal is only applicable to the submitted portion. This approval is provisional based on the receipt and review of the remainder of the required Submittals and may be modified or rescinded based thereupon.
2. Submittals are required before installation or fabrication begins. The Contractor shall not procure any equipment or perform any fabrication on any portion of this scope that has not received approval as defined herein. The Contractor shall be responsible for any costs related to returning, replacing, or not using any component of this scope that is ordered, fabricated, or installed prior to receiving such approval. Pay requests will not be approved for any work performed without approved Submittals.
3. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and the Drawings, and shall indicate compliance with each requirement specified herein and indicated in the Drawings:
   a. In addition to any other transmittal or cover sheet used, fill out and attach to each individual Submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
   b. Indicate manufacturer's installation instructions.
   c. Indicate deviations, if any, including any from the manufacturer's installation instructions.
   d. Reproductions or electronic versions of Design Drawings shall not be used in the preparation of Submittals. Submittals containing such Drawings may be rejected.
   e. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
   f. Submittals not specifically required, or not complying the format requirements, will be returned unreviewed.
   g. All electronic documents shall be provided in PDF format. PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
4. Submittals shall include the following:
   a. Floor Plans and/or RCPs showing the location of each projection screen and projection screen control device.
   b. The projection screen manufacturer's submittal form completed specifically for this Project. When this scope includes multiple projection screens, one submittal form shall be submitted for each screen and shall indicated the space in which that screen will be installed.
   c. Product data sheets on all equipment, materials, and cables related to the projection screens that are not included on the projection screen manufacturer's submittal form.
   d. Drawings showing connections to suspension systems and details showing the screen's anchoring to structure.
   e. Details of juncture of exposed surfaces with adjacent finishes.
   f. Dimensioned shop drawings of all fabricated, custom, or modified hardware, components, or devices. Provide a finish sample for all exposed finishes.
   g. A table indicating the color of all pieces of equipment that will be mounted, installed, or used in any generally accessible area of the spaces included herein. Unless otherwise noted, this requirement does not apply to equipment permanently installed in equipment rooms, telecommunications rooms, or other closets that are generally accessible only by the Owner's staff or their designees.

h. Dimensioned shop drawings of all fabricated, custom, or modified hardware and software equipment, components, or devices. Provide a finish sample for all connector plates furniture, consoles, carts, and stands.
i. Schematic drawings of all custom electronic components, assemblies, and circuitry.
j. Seismic and wind restraint devices, including calculations, restraint selection, installation details, and written confirmation that a licensed engineer prepared the calculations.
k. Required raceways and power outlets, including quantity, locations, and capacity characteristics.
l. Environmental requirements, including heat release.

C. Post-Construction (Closeout) Submittal Requirements:
1. The Operation and Maintenance Documentation package as defined in PART 3 of this Section. A draft version of this package shall be submitted as one comprehensive package to the Owner two weeks before the substantial completion inspection, shall be updated and revised as necessary during and at that inspection and completion of commissioning, and shall be finalized at the time of final acceptance.
2. The systems in this Project shall not be deemed "finally accepted" until the final version of the Operation and Maintenance Documentation package has been delivered to the Owner. The Contractor shall obtain a receipt from the Owner stating that the Operation and Maintenance Documentation package has been received.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Systems or equipment installed in environmentally controlled areas shall meet performance requirements specified herein in the following conditions:
1. Temperature: 40°F to 95°F.
2. Humidity: 20% to 80% RH.
3. Air purity: systems shall be capable of continuous operation in an environment where the level of dust, lint, paper fiber, and other airborne particles is equal to that found in a standard office.

B. Systems or equipment installed in indoor environmentally uncontrolled areas shall meet performance requirements specified herein in the following conditions:
1. Temperature: 0°F to 120°F.
2. Humidity: 5% to 95% RH.

C. Systems or equipment installed in outdoor areas shall meet performance requirements specified herein in the following conditions:
1. Wind-driven dust, dirt, sand, and snow for 6 hours.
2. Rain at a maximum rate of 4.0"/hour.
3. Ice loads up to 2.0" measured radially to exposed surfaces.
4. Wind: 85 mph, maximum.
5. Sleet with wind: 55 mph, maximum.
6. Snow cover: 2.0' maximum, measured vertically.
7. Humidity: 0% to 100% RH.
8. Temperature: -30°F to 150°F.

1.06 SPACE CONDITIONS

A. Verify dimensions of equipment, equipment arrangements, space availability (including any millwork or cabinetry provided by others), and provide systems that work within the constraints of the space available. Inform the Architect of any situation where space constraints are a problem, prior to the ordering or purchase of equipment. The Contractor shall bear the expense of providing alternate equipment which will work within the available space if space availability problems are discovered after equipment is ordered.

B. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location and offsets of the same, which are not shown on the Drawings but are necessary in order to accommodate building conditions

and coordination with the work of other trades, shall be made during the production of shop drawings and prior to initial installation, without additional cost to the Owner.

C. Provide access to equipment and components requiring operation, service, or maintenance within the life of the system.

1.07 WARRANTY

A. Equipment shall be free of faulty workmanship and defects for a period of 1 year from date of Substantial Completion.

B. Replace defective materials and repair faulty workmanship within 2 days of notification at no cost to the Owner during warranty period.

C. In addition to warranty service, provide maintenance service for the warranty period, including at least 2 semi-annual visits to site for checking and adjustment of equipment. During this period, answer service calls within 24 hours. During this period, maintenance calls shall be completed within 3 days of notification and at no cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise specified herein, quantities of equipment are indicated on the Drawings, and performance values specified herein are minimum acceptable values.

B. All projection screen shall be from a single manufacturer, unless otherwise noted on the Drawings.

C. See the Projection Screen Schedule on the Drawings for additional requirements.

D. All products shall be UL listed.

E. Manufacturer: Da-Lite, Draper, DNP, Stewart Filmscreen.

2.02 FRONT PROJECTION SCREENS

A. Material and Viewing Surfaces:
   1. Screen fabrics shall be mildew resistant and shall be flame resistant in accordance with NFPA 701-2019.
   2. Viewing surfaces shall be seamless unless otherwise indicated on the Drawings.
   3. Edge treatments hall be black masking borders unless otherwise indicated on the Drawings.

B. Electrically Operated Front Projection Screens:
   1. Screens shall be mounted such that the top edge of the fabric is securely anchored to a rigid metal roller and the bottom edge is formed into a pocket holding a weighted metal rod with the ends of the rod protected by plastic caps.
   2. Provide tab-tensioning where indicated on the Drawings.
   3. Provide additional black drop as required to achieve desired viewing height as indicated on the Drawings.
   4. Each screen shall include case, screen motor, controls, mounting accessories, and any other necessary components for a complete installation.
   5. Provide three stage low voltage controller capable of raising, lowering, and stopping screen travel. Low voltage switch shall be a three-button keypad with cover plate at locations indicated on the Drawings.
   6. Provide low voltage control connections to the Audio-Visual control system where shown on the Drawings.
   7. Motors shall be instant-reversing, gear-drive, end-mounted type with permanently lubricated ball bearings, automatic thermal overload protection, preset limit switches to automatically stop the screen in up and down positions, and positive stop action to prevent coasting.
   8. Where indicated on the Drawings, an automatic closure shall cover the screen opening when the screen is in the retracted position.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide all necessary incidental equipment or devices to deliver a complete and operable system.

B. Verify correctness of parts lists and equipment model numbers and conformance of each component with manufacturer's specifications.

C. Equipment shall be installed in accordance with the manufacturer's instructions.

D. Equipment, except portable equipment, shall be held in place. This shall include equipment, enclosures, components, and cables. Fastenings and supports shall support their loads with a safety factor of at least 3 unless otherwise specified herein.

E. Prevent and guard against electromagnetic and electrostatic hum and install the equipment to provide safety for the operator.

F. Repair or replace any equipment or materials damaged during the construction or installation period.

G. Provide power connections as required.

H. Cut and repair walls and ceilings, including inaccessible and tile grid systems, as required to install the projection screens.

I. Coordinate layout and installation of projection screens with other construction supported by, or penetrating through, ceilings, including luminaries, HVAC equipment, fire protection systems, and partitions.

J. Projection screens shall not be supported by or suspended from any other building system, including but not limited to HVAC equipment, plumbing, telecommunications equipment, raceway, or fire protection equipment.

K. Initial projection screen delivery and installation shall include only the projection screen case and mounting hardware. Install the case when the building is enclosed and other construction within spaces where screens will be installed is substantially complete. Deliver and install the roller assembly, motor, and fabric at a time when the building is dust-free. Coordinate with other trades as required.

L. Procure and install each projection screen as a complete unit, including mounting hardware and accessories. Do not deliver projection screens until the building is enclosed, other construction within spaces where screens will be installed is substantially complete, and installation of screens is ready to begin.

M. Coordinate and verify with Architect the screen size, black drop, height of the bottom of viewing area, case mounting height and configuration, mounted depth, and required edge tolerances with construction of wall recesses to house screens prior to ordering screens that are mounted in walls.

N. Coordinate requirements for blocking and structural supports to ensure adequate installation of screens.

O. Prior to installation of electrically operated screens, verify the type and location of the power supply.

P. Install projection screens at locations indicated on the Drawings and comply with the projection screen manufacturer’s written instructions and shop drawings.

3.02 FRONT PROJECTION SCREENS

A. Install manually and electrically operated front projection screens with screen cases in position and relationship to adjoining construction indicated on the Drawings. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.

B. Adjust limit switches to ensure correct positioning, screen tensioning, and silent screen case opening and closure.

C. Test electrically operated units to verify that screen, controls, limit switches, closure, and other operating components function.

D. Provide access to equipment requiring connections or service within the life of the assembly.

3.03 PROJECTION SCREENS PERFORMANCE VERIFICATION

A. Performance Verification of these systems shall be performed in conjunction with the Performance Verification requirements in Section 26 00 90, Electrical Performance Verification.

B. Performance Verification of the equipment included herein should be conducted in accordance with requirements in other Specification Sections that cover related equipment.

C. Verify that projection screens are installed level and flat.

D. Verify that no extraneous noise is made by any component of the projection screen assembly as the tensioning bar at the bottom of the screen enters or exits the screen case.

E. Verify that the viewing surface is square and not contorted in any way.

F. Where projection screens are recessed in a tile grid ceiling, verify that the grid is properly installed around the case and tiles are cut as necessary.

G. Verify that projection screens descend to the proper viewing height and retract completely into the case. Where applicable, verify that the screen case closure opens and closes without extraneous noise.

H. Verify that projection screen switches operate the intended functions (i.e., UP, DOWN, and STOP).

END OF SECTION

SECTION 27 53 13 - CLOCK SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Master clock control unit.
   2. Secondary indicating clocks.
   3. Program signal devices.
   4. Interface with system.
   5. System wire and cable.

1.02 DEFINITIONS

A. Federal Communications Commission (FCC): U.S. agency responsible for regulating the use of wireless frequencies.

B. Innovation, Science and Economic Development (ISED): Canadian agency responsible for regulating the use of wireless frequencies.

C. NIST: The National Institute of Science and Technology.

D. NTP: Network Time Protocol.

E. PC: Personal computer.

F. PoE: Power over Ethernet.

G. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:
   1. Master unit.
   2. Indicating clocks.
   3. Signal equipment.
   4. Equipment enclosures and back boxes.
   5. Accessory components.

B. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring and correction circuits.

      a. Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
      b. Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Indicate protection from overcurrent, static discharge, and voltage surge.

   2. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:

      a. Surface-mounted and semirecessed secondary indicating clocks.
      b. Master clock.
      c. Clock circuit power boosters.

   3. Details of seismic strengthening of master clock.

4. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Indicate internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

C. Radio Frequency Site Survey:
1. Perform predictive survey of Project site to determine equipment necessary to achieve reliable RF system coverage.
2. Submit Radio Frequency Site Plan indicating the following:

a. Site topography.
b. Present structures requiring or affecting RF coverage.
c. Necessary RF coverage area.
d. Minimum RF signal strength.
e. Location, type, and output power of necessary transmitters and repeaters to achieve indicated RF coverage.

D. Samples for Initial Selection:
1. Manufacturer's color photographs or color chips indicating the full range of colors available for clocks, signal equipment, and control panels.
2. Representative operating models of clock type.

E. Delegated Design Submittal: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of the master clock and housing.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for the master clock, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined in accordance with.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.02 MASTER AND SECONDARY CLOCK SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Primex Inc.; OneVue or comparable product by one of the following:

1. American Time & Signal Co.
2. Telecor Inc.

B. System Functions and Features:

1. Maintain correct synchronized time and transmit time-correction signals over wired Ethernet network from a master clock to any one type(s) of secondary indicating clocks, including the following:

    a. Analog Synchronous Clocks: Correct for minute- and second-hand synchronization and hour-hand synchronization at least once each day.
    b. Digital Clocks: Test clocks automatically for synchronization with master time control at least once every day and automatically correct those not synchronized with the time reference unit. Automatically correct clocks immediately when power is restored after an outage of power to the master clock.

2. Initiate and execute programs for scheduled automatic operation of remote devices.
3. Provide for manual control of programmed signal and equipment-switching circuits.
4. Communicate with cloud service to permit programming from remote location.
5. Maintain system access security with a minimum of one level of user-access control to restrict use of system controls to authorized personnel. Levels of access apply to both local access and access from a remote computer. Access to user programming and control functions is accomplished by entering a minimum three-digit code. Access levels include the following:

    a. Access to review existing programs only.
    b. Access to normal system operating controls.
    c. Access to all user-programming and control functions.

6. Regulate system timing functions using Ethernet network NTP, backed up for power outages by an internal battery-powered, crystal-controlled oscillator.
7. Provide for programming multiple independent event schedules into memory and running them simultaneously for different output circuits.

    a. Quantity of Programmable Schedules: Four , minimum.
    b. Number of Weekly Events That Can Be Programmed for Each Schedule: 128 , minimum.
    c. Simultaneous operation of independent schedules shall be limited only by the number of signal-device and equipment-switching output circuits.
    d. Advance Programming for Automatic Holiday Schedule Changes: Number of schedule changes that can be programmed to suit holidays and vacations shall be 16, and each change may be programmed up to a year in advance to occur on any day of the calendar year.

8. Automatically check functioning of LEDs, switches, input keys, central processor, read-only memory, random access memory, and output circuits. A display on the control panel shall indicate failure by identifying faulty component or circuit and shall recommend corrective action.
9. Provide programming for automatic daylight saving time correction.
10. Provide for adjustments to master clock output signals. Duration of momentary signal shall be individually programmable for each signal and equipment-control output circuit from 1 to 99 seconds. Signals shall be programmable for either on or off switching to suit equipment-operation scheduling.

2.03 MASTER CLOCK, 72MHZ

A. Description: Microprocessor-based, software-controlled unit distributing time synchronization signals to secondary clocks wirelessly via licensed 72 MHz radio frequency.

B. Features:
1. Receives setting updates and reports status over facility IP network.
2. Transmitter Power Output.
3. Antenna Type.
4. Time Source.
5. GPS Antenna Cable Length.
6. Minimum Transmitter Channels: 49.
7. Power Connection: 120 V ac, cord with plug connector**.**
8. Operating Temperature: 32 to 122 deg F.

2.04 MASTER CLOCK, BLUETOOTH

A. Description: Microprocessor-based, software-controlled unit complying with Class A device requirements in 47 CFR 15 communicating with secondary clocks using adaptive, self-healing low-energy Bluetooth wireless mesh network.

B. Features:
1. Receives setting updates and reports status over facility IP network.
2. Time Source: NTP.
3. Capable of supporting 200 secondary clocks.
4. Battery backup sufficient for 8 hours of operation without external power.
5. LCD display.
6. Status LED indicators for eternal power, connection issue, and loss of time sync.
7. Housing: ABS plastic suitable for wall mounting.
8. Power Connection.
9. Operating Temperature: 32 to 122 deg F.

C. Certifications:
1. FCC.
2. CE.
3. IC.
4. Bluetooth.

2.05 SECONDARY INDICATING CLOCKS

A. Analog Clock: Equipped with a sweep second hand. Movement shall be driven by self-starting, permanently lubricated, sealed synchronous motor equipped with a correcting solenoid actuator.
1. Display Size: 12-1/2-inch diameter.
2. Dial Face Color: red.
3. Dial style: digital.
4. Lens: Clear thermoplastic.
5. Frame: High-impact thermoplastic.
6. Finish: Black.
7. Tamper-proof/theft resistant clock-lock mounting slots.
8. Operating Temperature: 32 to 95 deg F.
9. Power Connection: PoE 802.3 at/af compatible.

B. Digital Clock: Microprocessor-controlled unit complying with Class A device requirements in 47 CFR 15, with red LED digital time display of hours and minutes , minutes, and seconds.
1. Display Height: 2-1/2-Inch Clock: Hour and minute numerals readable at 50 ft.
2. Display Height: 4-Inch Clock: Hour and minute numerals readable at 100 ft.
3. Display Format: Selectable between 12-hour with "PM" LED display and 24-hour formats.
4. Four- digit, seven-segment digital display.
5. Alternating time and date display.
6. LED dimmable to 75, 50, or 25 percent.
7. Frame Enclosure: ABS plastic.
8. Clock Lens: Acrylic.
9. Operating Temperature: 32 to 95 deg F.
10. Power Connection: PoE 802.3 at/af compatible.

C. Interval-Timer Clock: Digital microprocessor-controlled unit with red LED digital display for hours and minutes and 1-5/16-inch display for seconds; a separately mounted, mode-control switch; and the following features:
   1. Display Height: 2-1/2-Inch Clock: Hour and minute numerals readable at 50 ft.
   2. Display Height: 4-Inch Clock: Hour and minute numerals readable at 100 ft.
   3. Six-digit, seven-segment digital display.
   4. LED dimmable to 75, 50, or 25 percent.
   5. Operating Temperature: 32 to 95 deg F.
   6. Operating Modes:

      a. Normal: Clock operates as a regular secondary system clock, displaying corrected time in normal display configuration, selectable between 12- and 24-hour formats, with "PM" digital display for 12-hour format.
      b. Count-Down or Count-Up Timer: Selected by mode-control switch count-up and count-down positions, and capable of being preset at the mode-control station.
      c. Code Blue: Automatically selected by a signal through a wiring connection from. This signal captures control of the clock regardless of current mode or correction status and instantly initiates count-up operation, starting at time 00:00:00. While in this mode, other clock functions, including correction, shall run in the background. Clock shall revert to normal operating mode when the initiating-signal system is reset.
      d. Mode-Selector Switch: Membrane type, flush mounted; with start, stop, and reset capability in both count-up and count-down modes.
      e. Audible tone signal: Housed in clock or mode-selector-switch box. Sounds at end of preset up or down count.
      f. Power Connection: PoE 802.3 at/af compatible.

D. Secondary Indicating Clock Characteristics:
   1. Clock Type: Digital.
   2. Face Configuration: Single.
   3. Mounting: Surface.
   4. Casing Finish.
   5. Special Environmental Conditions.

2.06 CONFIGURATION SOFTWARE

A. Cloud based, accessible through common web browser on mobile device or computer with no required installation of software or third-party plug-ins or applications.

B. Software Features:
   1. Stores and maintains redundant data backups.
   2. Receives and stores system device event logs recording event type, time, and date.
   3. Monitors and displays current operating status received from text display boards.
   4. Displays monitoring data including condition of text display devices, and historical device operating condition and event data.
   5. Allows authorized user to modify the following system parameters:

      a. Display brightness.
      b. Time display color.
      c. Date display color.
      d. Date format.
      e. Message display color.
      f. Message display scroll speed.
      g. Content of noncritical message, up to 64 characters.
      h. Display intervals.

   6. Capable of generating text (SMS), email, and voice alert messages when a system transmitter device operating condition warrants corrective action.

2.07 PROGRAM SIGNAL DEVICES

A. Bells: Heavy-duty, modular, vibrating type with the following sound-output ratings measured at 10 ft.:
   1. 4-Inch Bell: 90 dB.
   2. 6-Inch Bell: 95 dB.
   3. 10-Inch Bell: 104 dB.

B. Chimes: Heavy-duty, modular, vibrating chimes with polished-chrome tone bar and enamel-finished housing. Minimum sound-output rating measured at 10 ft. shall be 75 dB.

C. Clock Buzzers: Adjustable output signal device designed for mounting within clock housing or outlet box.
   1. Sound-Output Rating Measured at 3 Ft.: 75 dB.
   2. Audible Tone Frequency: Manufacturer's standard between 120 Hz and 2 kHz.

D. Horns: Modular, adjustable-output, vibrating type with minimum full-intensity-rated sound output of 103 dB measured at 10 ft.

E. Projector Horns: Adjustable-output, vibrating type with projector arranged to channel sound in the direction of the projector axis, and with minimum full-intensity-rated sound output of 104 dB measured at 10 ft.

F. Loudspeakers for Audible Tones: See Section 27 51 16 "Public Address and Mass Notification Systems."

G. Visible Signal Devices: Strobe lights with polycarbonate lens and xenon flash tube, with lens mounted on an aluminum faceplate and the word "Program" engraved in letters at least 1 inch high on lens. Lamp unit shall have a minimum rated light output of 75 candela.

H. Combination Audible and Visible Signal Devices: Factory-integrated horn and strobe light in a single mounting assembly.

I. Outdoor Signal Equipment: Weatherproof models listed for outdoor use.

J. Mounting Arrangement for Signal Devices: Designed for attachment with screws on the mounting plate of a flush-mounted back box unless otherwise indicated.

K. Enclosures for Flush-Mounting Bells and Horns: Enclosure, mounting plate, and grille assembly shall be furnished by device manufacturer to match features of the device to be mounted. Enclosure shall be recessed in wall, completely enclosing the device, with grille mounting over the open side of the enclosure and flush with the wall.

L. Connection Provision for Signal-Indicating Devices.

2.08 BACK BOXES FOR SECONDARY INDICATING CLOCKS AND PROGRAM DEVICES

A. Description: Box and cover-plate assembly shall be furnished by device manufacturer and be suitable for device to be mounted. Back boxes shall be equipped with knockouts and hanger straps or mounting adapters arranged for flush mounting the device unless otherwise indicated.
   1. Compliance: UL 50E.

2.09 GUARDS

A. Description: Formed-steel wire, shaped to fit around guarded device, with 1-inch maximum clearance.
   1. Mounting Provisions: Fixed tabs, welded to guard and arranged for screw attachment to mounting surface.
   2. Finish: steel with zinc plating.

B. Description: Clear polycarbonate, shaped to fit around guarded device, with 1-inch maximum clearance.
   1. Mounting Provisions: Fixed tabs, integral to guard.
   2. Water-resistant gasket for high-humidity areas.

2.10 RACK-MOUNTING PROVISION FOR MASTER CLOCK

A. Equipment Cabinet: -mounted, rack type. Comply with EIA-310-D and the following:

1. Cabinet Housing: Constructed of steel, with front doors; with manufacturer's standard tumbler locks, keyed alike.
   a. Front door shall have a clear panel in front of the master clock display.
   b. Housing shall enclose master clock and auxiliary clock system components, plus a minimum of percent spare capacity for future equipment.
2. Forced Ventilation: Internal low-noise fan with a filtered intake vent, connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable and arranged to be powered when main cabinet power switch is on.
3. Natural Ventilation: Ventilated rear and sides with louvers and solid top.
4. Arrange inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
5. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by equipment or panels.
6. Finish: Uniform, baked-enamel, finish over rust-inhibiting primer.
7. Power-Control Panel: On equipment housing; with master power on-off switch.

2.11 CONDUCTORS AND CABLES

A. Category 6 Twisted Pair Cable:
   1. Description: Four-pair, balanced-twisted pair cable certified to meet transmission characteristics of Category listed above.
   2. Standard: Comply with TIA 568-C.2 for Category listed above.
   3. Conductors: 100-ohm, No. 23 AWG solid copper.
   4. Shielding/Screening: Screened twisted pairs (F/UTP).
   5. Cable Rating: Plenum.
   6. Jacket: White Blue thermoplastic.

2.12 PATHWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 27 05 28 "Pathways for Communications Systems."

B. Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

C. Intercommunication and Program System Raceways and Boxes: Surface metal raceways.

D. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

E. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Section 27 05 48.16 "Seismic Controls for Communications Systems."

3.02 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Support cables not enclosed in raceways on J-Hooks. Install, size, and space J-Hooks to comply with TIA-568-C.

3.03 ELECTRICAL CONNECTIONS

A. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

B. Use plug connectors for connections to clocks and signal devices.

C. Ground clocks, programming equipment, and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.04 IDENTIFICATION

A. Comply with Section 27 05 53 "Identification for Communications Systems."

B. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

B. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
1. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

D. Clock system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.06 ADJUSTING

A. Program system in accordance with Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.

B. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.

C. Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

END OF SECTION

SECTION 28 46 21.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.01 GENERAL

A. This specification includes the furnishing, installation, and connection of the microprocessor controlled; intelligent reporting fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring.

B. The fire alarm system shall comply with applicable provisions of the NC Building Code, NFPA 70 - National Electrical Code (NEC), NC Fire Code, and NFPA 72 - National Fire Alarm and Signaling Code. The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.

C. Scope description: This section provides product description and installation requirements for the new fire alarm system.. Refer to section 01 23 00 for description of all alternate scope options.

D. The system shall have 60 hours battery power capacity, plus 15 minutes of full alarm load.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products are Listed and Labeled. Products of firms that do not maintain factory authorized service organization and spare parts stock are not acceptable for use on State Owned Buildings.

B. Acceptable Manufacturers:
1. Edwards; Carrier Global Corporation.
2. Notifier; Honeywell International, Inc.
3. Simplex; Johnson Controls, Inc.
4. Siemens, Inc.

C. Installer’s Qualifications: Company specializing in performing the work and making the final terminations and connections. Personnel must be NICET Level III certified. Minimum of 5 years documented experience installing fire detection and alarm systems similar in size and scope to the project. Only the Installer may make program changes and must be present for the 100% test, Engineer’s pre-final review and Owner inspections.

D. All connections to the FACP and the system's programming shall be done only by the manufacturer, or by an authorized distributor that stocks a full complement of spare parts for the system. The technicians are required to be trained and individually certified by the manufacturer, for the FACP model/series being installed. This training and certification must have occurred within the most recent 36 months. Copies of the certifications must be part of the Shop Drawing submittal, prior to installation. The submittal cannot be approved without this information.

E. The person that programmed the system must be present for the Engineer’s and State Construction Office final inspection.

1.03 CODES AND STANDARDS

A. NFPA Compliance: Comply with applicable requirements of 2013 NFPA 72, National Fire Alarm and Signaling Code.

B. NEC Compliance: Comply with applicable requirements of 2020 NFPA 70, National Electrical Code (NEC) standards pertaining to fire alarm systems.

C. Comply with applicable requirements of 2018 NC Building Code and 2018 NC Fire Code.

D. Comply with applicable requirements of SCO 2020 Fire Alarm Guidelines and Policies.

E. Comply with applicable requirements of 2021 University Design Guidelines.

F. Testing Laboratory Compliance: Comply with provisions of UL safety standards pertaining to fire alarm systems. Provide products and components which are Listed and Labeled. Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.

G. FM Compliance: Provide fire alarm systems and accessories which are FM approved.

H. Fire alarm control panel shall conform to the requirements of UL 864 Category UUKL.

1.04 RELATED REQUIREMENTS

A. Section 26 05 33 "Raceway and Boxes for Electrical Systems" for conduit requirements.

B. Section 26 05 53 "Identification for Electrical Systems" for fire alarm conduit identification and labeling requirements.

C. Section 28 33 00 “Rescue Assistance Communication System” for two-way communication callboxes and associated equipment.

D. Section 01 23 00 “Alternates” for description of alternate scope options.

1.05 DEFINITIONS

A. For State-owned facilities in North Carolina the AHJ for Code compliance is the NC Department of Administration – State Construction Office. The AHJ for construction administration and inspection purposes is the designer of record.

B. Building Permits: State Construction Office (SCO) ID Number serves as the permit for construction or renovation of facilities that are funded by the State of North Carolina and located on State- owned land. However, privately funded projects on land leased from the State (e.g., student housing) must still be submitted to local building officials for approval, permits, and inspections. Written NCDOA/SCO approval of the plans and specifications submitted for review is considered the equivalent of a building permit for State projects but that alone does not give authorization to proceed with construction. Such authorization requires written clearance from the entity that administers the contract.

C. Fire Alarm Control Panel (FACP) - Also called a Fire Alarm Control Unit (FACU)

D. Remote Annunciator (FAA) – Provides LCD display with a text statement of the panel status and/or LED lamps to indicate the status of the fire alarm system.

1.06 SUBMITTALS

A. Submittals must be approved by the Engineer prior to beginning installation.

B. Product Data: for each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.
3. Include mA draw for each device submitted and the listed minimum voltage required to operate. Panel submittal shall list voltage drop allowed for panel and for individual NAC circuits.

C. Shop Drawings:
1. The fire alarm Contractor shall submit complete Shop Drawings to the Engineer for review prior to performing any work. Shop Drawings shall clearly demonstrate compliance with the Engineer’s plans and specifications, which have a System Response Matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. Any non-compliant features must be fully described. Shop Drawings must comply with the NC Fire Code, Section 90 7. 1.2.
2. The submitted shop drawings shall show equipment, device identification numbers and locations, and connecting wiring of entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams shall be based on the project floor plans, with devices and

proposed conduit routing. The conductor composition for each conduit section shall be provided. The distance and route for each NAC (Notification Appliance Circuit) including speaker and strobe circuits shall be shown. Riser diagrams shall show consecutive connections for all devices with addresses and wattage and candela ratings.

3. Engineer's approval (with or without corrections) of Contractor's Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the Contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the Engineer gives written authorization.

D. Installation Instructions: The Contractor shall submit to the Engineer the Manufacturer's detailed installation instruction for the Fire Alarm Control Panel and all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.

E. Battery and Voltage Drop Calculations:
1. Include battery sizing calculations with the shop drawing submittal to the Engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 60 hours of providing standby power and 15 minutes of alarm, or use 85% of nominal system voltage per NFPA 72, whichever is lower. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at End of the Line Resistor (EOL), based on conductor resistance per conductor manufacturer's data sheet or NEC.
2. Contractor calculations must be submitted with the shop drawings, and prior to installation of equipment. In the submittal package identify Notification Appliance Circuits (NAC) current draws and voltage drops for each circuit. Contractor must utilize the "end of line" method for voltage drop calculations. This assumes the total current for all devices on the circuit is carried from the source to the end of the line. Include the losses in both the positive and negative conductors in the circuit. The "mid-point" method is not acceptable. In no case shall the calculated voltage at any notification appliance fall below the minimum listed operating voltage for the devices used.
3. The voltage drop at EOL must not exceed 80% of voltage difference between the minimum source voltage and minimum device voltage. For a nominal 24-volt system, this limits the maximum voltage drop from the battery to the EOL to 3.5 volts (20.4 volts at the source minus 16 volts for minimum device voltage). All these calculations must be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians.
4. Provide copies of battery and voltage drop calculations at SCO final inspection.

F. Maintenance Data: The Contractor shall submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual.
1. Inspection and testing of the fire alarm system in accordance with the requirements of NFPA 72 Chapter 14

G. Certifications:
1. Submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses, and telephone numbers in the certification.
2. Installer's training certificate as defined under Quality Assurance.

PART 2 - PRODUCTS

2.01 FIRE ALARM CONTROL PANEL (FACP)

A. FACP - General: The FACP shall meet the following general requirements (unless otherwise required by the Owner for certain systems):

1. The system is to be the addressable type, with a 24vdc nominal operating voltage.

2. The system is to have multiple access levels, so Owner's authorized personnel can disable individual alarm inputs or normal system responses (outputs) for alarms, without changing the system's executive programming or affecting operation of the rest of the system. The process on how to do this must be included in the training required to be given to the Owner's designated personnel and must also be part of the written documentation provided by the fire alarm equipment supplier.
3. Signal Line Circuits: (SLC) also called addressable loop - Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto an NFPA Style 6 (Class A) Signaling Line Circuit (SLC) with no “T” taps.
4. Initiation Device Circuits: Initiation Device Circuits (IDC) shall be wired Class B.
5. Notification Appliance Circuits: Notification appliance circuits shall be wired Class B.
6. Digitized electronic signals shall employ check digits or multiple polling. In general, a single ground or open on any system signaling line circuit shall not cause system malfunction, loss of operating power, or the ability to report an alarm.
7. Loss of Power: Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
8. The FACP must have an Alarm Silence switch and be equipped with the Subsequent Alarm (alarm resound) feature. Any remote annunciators or graphic displays located away from the alarm area must also include an audible signal with alarm resound feature.

B. Acceptable Manufacturers and Models:

1. Edwards, Carrier Global Corporation, Model EST3
2.
3. Notifier, Honeywell International, Inc., Model NFS2-3030
4. Simplex, Johnson Controls, Inc., Model 4100ES
5. Siemens, Inc., Model Fire Finder XLS

C. System Response to an Alarm Condition: When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

1. The system alarm LED shall flash.
2. A local piezo-electric signal in the control panel shall sound.
3. An 80-character minimum LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing and history storage equipment shall log the information associated with each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event equations activating a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated. Exact programming shall be provided by the Contractor to meet the Owner’s requirements.
6. Detect activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
7. Activate all fire alarm Notification Appliances in the building, sounding and flashing in synchronization continuously until the initiating device and control unit have been reset to normal condition.
8. Activate digital alarm communicator and transmit alarm signal to Remote Supervising Station.
9. Deactivate door hold control relay such that all smoke doors close.
10. Deactivate control relays so that HVAC units shut down. Exception is for hazardous exhaust systems.

11. Activate elevator recall sequence if smoke is detected in any elevator lobby, shaft, or in the elevator equipment room.
12. Activate control relay(s) to release all magnetically locked egress doors.

D. System Response to a Trouble Condition:

1. Systems AC power trouble signal shall not be sent unless maintained for more than 1 hour. Provide additional relays as required for this purpose.
2. Provide immediate transmission of all other supervising signals.
3. Provide adjustable time delay for all other trouble signals prior to transmission.

E. FACP - Minimum Requirements: The FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU and its associated equipment shall be protected so it cannot be affected by voltage surges or line transients consistent with UL standard 864. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, local and remote operator terminals, printers, annunciators, and other system-controlled devices. The main FACP shall perform the following functions:

1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
2. Supervise all initiating, signaling, and notification circuits throughout the facility by way of connection to monitor and control modules, or end of line resistor.
3. Visually and audibly annunciate any trouble, supervisory or alarm condition on operator's terminals, panel display, and annunciators.

F. System Capacity and General Operation: Approved system design shall have the following capacities and general operation modes:

1. The FACP shall provide or be capable of expansion to 198 intelligent/addressable devices per Signaling Line Circuits (SLC) and 1980 initiating points, minimum, per system. The number of SLCs provided shall be as indicated on the Drawings, minimum one loop per floor. Total points shall be as indicated on the drawings or otherwise specified with minimum 20% spare capacity.
2. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit, 80 minimum character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
3. All programming or editing shall be achieved with a personal computer on site. A copy of the database shall be left in the Document Box per NFPA 72.
4. Notification Appliance Circuits with 20% spare current and voltage drop capacity.

G. The FACP shall be able to provide the following features:

1. Upload/Download to PC Computer

2. Charger Rate Control
3. Drift Compensation
4. Automatic Day/Night Sensitivity Adjust
5. Device Blink Control
6. Pre-alarm Control Panel Indication
7. Trouble Reminder
8. NFPA 72 Smoke Detector Sensitivity Test
9. System Status Reports
10. Periodic Detector Test

11. Alarm Verification, by device, with tally
12. Non-Alarm Module Reporting
13. Block Acknowledge
14. Smoke Detector Maintenance Alert
15. Control-By-Time

H. The control panel shall be capable of printing historical data and device parameters and shall include all equipment necessary to produce printouts, including an external printer and shall be listed as meeting the NFPA 72 sensitivity testing and maintenance requirements without the need for manually removing and testing each smoke detector. The control panel shall provide a display and a printed list of these sensitivity measurements as a permanent record of the required sensitivity testing. The system shall also annunciate a trouble condition when any smoke detector approaches 80% of its alarm threshold due to gradual contamination, with an annunciation of the location of the smoke detector requiring service. If any specialized equipment must be used to program any function of the smoke detector devices, then one must be furnished as part of the system.

I. The system shall perform time-based control functions including automatic changes of specified smoke detector sensitivity settings.

J. Central Processing Unit: The Central Processing Unit (CPU) shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the CPU.

1. The CPU shall contain and execute all control-by-event (including ANDing, ORing, NOTing, CROSSZONEing) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure. The CPU shall also provide a real-time clock for time annotation of all system displays. The Time-of-Day and date shall not be lost if system primary and secondary power supplies fail.
2. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

K. Operators Control: Provide an operator’s interface which allows the following minimum functions. In addition, the operator’s interface shall support any other functions required for system control and/or operation:

1. Acknowledge (ACK/STEP) Switch

2. Signal Silence Switch
3. System Reset Switch
4. System Test Switch
5. Lamp Test Switch
6. Programmable, supervised switches for fire safety function bypasses. i.e. NAC Bypass, Elevator Capture Bypass, HVAC Shutdown Defeat, , etc. Switch operation shall be password protected.

L. Display: The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

1. The system display shall provide an 80 minimum -character back-lit alphanumeric Liquid Crystal Display (LCD).

2. The Display shall also provide four Light-Emitting-Diodes (LEDs), which will indicate the status of the following system parameters: AC POWER, SYSTEM ALARM, SYSTEM TROUBLE, and SIGNAL SILENCE.
3. The system display shall provide a touch keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
4. Signaling Line Circuit (SLC) Interface Board: The FACP shall contain SLC interface boards as required to communicate with the SLC. Each SLC board shall monitor and control a minimum of 198 intelligent addressable devices. This includes 99 analog detectors (Photoelectric or Thermal) and 99 monitor or control modules.
5. Each SLC interface board shall contain its own microprocessor and shall be capable of operating in a local mode (any SLC input activates all or specific SLC outputs) in the event of a failure in the main CPU of the control panel. The SLC interface board shall not require any jumper cuts or address switch settings to initialize SLC Loop operations. SLC interface boards shall provide power and communicate with all intelligent addressable detectors and modules connected to its SLC Loop on a single pair of wires. This SLC Loop shall be capable of operation as NFPA 72 Class A (Style 6) or Class X (Style 7).
6. Each SLC interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that specific detector. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

M. Printer: Provide a printer to provide hard-copy printout of all changes in status of the system. The printer shall timestamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. Thermal printers are not acceptable. The printer shall operate from a 120 VAC, 60 Hz power source. Provide table and stand for printer.

N. Remote Transmissions: The FACP shall be interfaced to a Digital Alarm Communications Transmitter (DACT). DACT shall be interfaced with a Keltron radio dialer for primary communication and IP for secondary communication. Coordinate radio frequency with receiving station.

O. Power Supply: The FACP power supplies shall operate on 120 VAC, 60 Hz and shall have a continuous rating adequate to power all equipment and functions in full alarm continuously. All modules and drivers must be able to withstand prolonged short circuits in the field wiring, either line-to-line or line- to-ground, without damage. Further, the power supply shall be expandable for additional notification appliance power in 3.0 Ampere increments.

P. The power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge.

Q. Batteries: Shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have enough capacity to power the fire alarm system for not less than

R. 60 hours plus 15 minutes of alarm upon a normal AC power failure. NAC circuits shall not exceed 80% of maximum current load allowed.

S. Enclosures: The FACP shall be housed in a 3rd party listed cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be hinged on either the right or left side (field selectable).

2.02 ALARM APPLIANCES

A. Programmable Electronic Sounders: Sounders located outdoors shall be listed for use in wet locations. Electric sounders shall operate with synchronized audible output and have the following specifications:

1. Voltage: Programmable electronic sounders shall operate on 24 VDC nominal.
2. Programming: Electronic Sounders shall provide the ANSI S3.41 three-pulse temporal pattern audible evacuation signal, described in NFPA 72, with an output sound level of at least 90 dBA measured at 10 feet from the device. Output sound level shall be 110 dB maximum. Electronic Sounders shall be field programmable without the use of special tools.

B. Strobe Lights shall be located as shown on the Drawings. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:

1. Voltage: Strobe lights shall operate on 24 VDC nominal.
2. Maximum pulse duration: 2/10ths of one second.
3. Strobe intensity and flash rate: Must meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15 Cd, or greater if such is indicated adjacent to the device symbol on the Drawings. The Fire Alarm Contractor shall verify all candela settings prior to conducting the voltage drop testing required later in this specification. Contractor shall also verify the design candela settings are adequate for the space being covered. Care must be taken to assure the devices are mounted in the exact locations shown on the approved shop drawing documents. Notify the Engineer of any deficiencies.
4. Strobes shall have a white coverplate and shall be labeled “FIRE”

C. Speakers: Speakers, where provided, shall have audible sound with taps at 1/4-watt, 1/2-watt, 1-watt, 2-watts. Speakers shall operate at 25 V. Provide back boxes for all speakers. See additional requirements for Programmable Electronic Sounders. All speakers shall have a white coverplate.

D. Horns: Where provided, shall provide a sound level of 15 dBA above ambient as listed in the NFPA 72.

E. Audible/Visual Combination Devices shall comply with all applicable requirements for both Programmable Electronic Sounders and Strobe Lights.

F. Bells shall be 10" diameter vibrating type located as shown on the Drawings; bells located outdoors shall be listed for use in wet locations. Bells shall have the following specifications:

Voltage: Bells shall operate on 24 VDC nominal.

2.03 INITIATING DEVICES

A. Addressable Devices - General: All initiating devices shall be individually addressable. Addressable devices shall comply with the following requirements:

1. All addressable spot type and duct smoke detectors shall be the analog type and the alarm system shall automatically compensate for detector sensitivity changes due to ambient conditions and dust build-up within detectors. This feature must be armed, and sensitivities set prior to acceptance of the system.
2. Address Setting: Addressable devices shall provide an address-setting means.
3. Connections: Addressable devices shall be connected to a Signaling Line Circuit (SLC) with minimum two (2) wires.
4. Operational Indications: Addressable smoke and heat detectors shall provide dual LEDs. LEDs shall flash under normal conditions, indicating that the device is operational and in regular communication with the control panel. The flashing mode operation of the detector LEDs shall be optional through the system field program.
5. Intelligent Initiation Devices: All smoke detectors shall be the "intelligent" in that smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity shall be capable of being automatically adjusted by the FACP on a time-of-day basis. Using software in the FACP, detectors shall be capable of automatically compensating for dust accumulation and other slow environmental changes that may affect performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
6. Spot-type detectors must be the plug-in type, with a separate base (not a mounting ring), to facilitate their replacement and maintenance. The base shall have integral terminal strips for circuit connections, rather than wire pigtails.
7. Device mounting Base: Unless otherwise specified all detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature.
8. Test Means: The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel when in the "test" condition. Actual or synthetic smoke must be used during the 100% testing to assure smoke entry into the sensing chamber.
9. Device Identification: Detectors shall store an internal identifying type code that the control panel shall use to identify the type of device.

B. Photoelectric Smoke Detectors: Photoelectric smoke detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

C. Thermal Detectors: Thermal Detectors shall be intelligent addressable devices rated at 135°F (58°C) and shall have a rate-of-rise element rated at 15° F. (9.4°C) per minute. It shall connect via minimum two wires to the Fire Alarm Control Panel Signaling Line Circuit. Thermal detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.

1. Specialized Element Temperature Ratings: Provide thermal detectors with specialized element temperature ratings. Specialized element temperatures are indicated by a temperature rating adjacent to the thermal detector symbol, e.g. 195°F.
2. Rate Compensation Detector: non-addressable device rated at 135°F or 195°F, hermetically sealed, fast response, self-restoring. It shall connect to an addressable monitor module in a conditioned space.

D. Duct Smoke Detector: In-Duct Smoke Detector Housings shall accommodate a velocity rated photoelectric detector. The device, independent of the type used, shall provide continuous analog monitoring and alarm verification from the panel. When enough smoke is sensed, an alarm signal shall be initiated at the FACP. Coordinate with Owner for response appropriate for the location.

E. Addressable Pull Stations - General: Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except using a key. All pull stations shall be dual action, have a positive, visual indication of operation and utilize a key type reset. Glass-break rods are not allowed. Mount pull station with operating mechanism between 42-inches and 48-inches above finished floor.

2.04 MISCELLANEOUS SYSTEM ITEMS

A. Addressable Dry Contact Monitor Module: Addressable Monitor Modules shall be provided to connect one supervised zone, Class B (Style B) of non-addressable Alarm Initiating Devices (any Normally Open [N.O.] dry contact device) to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings.

1. Indication of Operation: An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
2. Supervision: Unless specifically noted otherwise on the drawings provide one monitor module for each sprinkler valve tamper, waterflow, and air pressure switch.

B. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay. The control module shall provide address-setting means. An LED shall be provided that shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel. If the voltage being controlled is 120 VAC or greater, an isolating 24 VDC relay shall be used.

1. Configuration: The control module NAC circuit shall be wired for (Class B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
2. Power Source: Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, 3rd party listed remote power supply. A/V power sources and connections are not shown on the Drawings.

C. Isolator Module: Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop to 20 addressable devices. Modules must be mounted at A/V device height and clearly labeled.

1. Operation: Isolator Modules shall operate such that if a wire-to-wire short occurs, the Isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section. The Isolator Module's operations shall be totally automatic.
2. The Isolator Modules shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

D. Water Flow Switch: Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Flow switches shall be located a minimum of one (1) foot from a fitting that changes the direction of the flow and a minimum of three (3) feet from a valve as required per NFPA 13.

E. Sprinkler and Standpipe Valve Supervisory Switch: Supervisory switch mechanisms shall be contained in a weatherproof housing that shall provide a 3/4-inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel.

F. Serially Connected Remote Annunciator: Annunciator shall communicate with the fire alarm control panel via an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones shall be as indicated on the Drawings. Up to 10 annunciators may be connected to the EIA-485 communications loop.

1. Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset. All annunciator switches and indicators shall be software programmable.
2. LCD Alphanumeric Display Annunciator: The Alphanumeric Display Annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD Annunciator shall display all alarms and trouble conditions in the system.
3. System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence and Reset.
4. Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.

G. Remote Annunciator Indicator Lights (RAIL): RAILs shall be provided. In addition. RAILs shall have the following features: Voltage: RAILs shall operate on 24 VDC nominal.

H. Door Hold-Open Magnets: Door hold open magnets shall be suitable for mounting in a single gang electrical device box. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings. Holding force of the magnet shall be appropriate for the door to be held open. Door hold open magnets shall operate in a fail-safe manner, i.e., the door shall release in event of a failure of voltage to the device. Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted. Door shall close within 60 seconds of the power loss.

I. Battery Power Supply (BPS) &/or Supplementary Notification Appliance Circuit (SNAC): These types of panels shall be completely maintenance free, shall not require liquids, fluid level checks or refilling, and shall not be capable of producing spills and/or leaks. Batteries shall be sealed gel-cell type with expected life of 10 years. Battery voltage shall be as required by the FACP and related equipment. Battery shall have enough capacity to power the fire alarm system for not less than 60 hours plus 15 minutes of alarm upon a normal AC power failure. Battery cabinet shall be twice the size of the batteries it will contain. NAC circuits shall not exceed 80% of maximum current load allowed.

J. Surge Protection: The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical Contractor:

1. On AC Input: A feed-through (not shunt-type) branch circuit transient suppressor shall be Ditek DTK 120SRD.
2. On DC Circuits Extending Outside Building: At a point near entry to the building provide "pi"- type filter on each leg, consisting of a primary arrestor, series impedance, and a fast-acting secondary arrestor that clamps at 30v-40v.

   Acceptable model: Ditek DTK 2MHLP24BWB series

2.05 WIRING

A. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair. Cable shield drain wires are to be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACP. Acceptable cables include Atlas 228-18-1-1STP, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having capacitance of 30pf/ft. maximum between conductors. Belden 5320FJ acceptable if only FPL rating needed. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.

1. Unshielded cable, otherwise equal to the above, is permitted to be used if the manufacturer's installation manual requires, or states preference for, unshielded cable.
2. In underground conduit, use Type TC or PLTC cable (PE insulated) to avoid problems from moisture.

2.06 EMERGENCY RESPONDER RADIO COVERAGE SYSTEM

A. Emergency responder radio coverage systems use a combination of bidirectional amplifiers and distributed antenna systems to boost signals for sustaining two-way radio communications throughout a facility, including stairwells, underground tunnels, parking garages, and other challenging areas.

B. In accordance with NFPA 72, emergency responder radio coverage systems must be designed, installed, and maintained in accordance with NFPA 1221. Installation shall comply with North Carolina Fire Code section 510.

C. Designer and lead installation personnel shall include both of the following:

1. A valid FCC-issued general radio operator’s license.

2. Certification of in-building system training issued by an approved organization or approved school, or a certificate issued by the manufacturer of the equipment being installed.

D. The system must have pathway survivability of 3 as defined in NFPA 72.

E. Where leaky feeder cable is used as antenna, it must neither be required to be installed in metal raceway nor meet survivability requirements.

F. Feeder and riser coaxial cables must be rated as plenum cables.

G. Feeder coaxial cables must be connected to riser coaxial cables using hybrid coupler devices of value determined by overall design.

H. The design of system must be approved by authorities having jurisdiction. Riser coaxial cables must be rated as riser cables and routed through 2-hour-rated enclosure.

I. Connection between riser and feeder coaxial cables must be made within 2-hour-rated enclosure, and passage of feeder cable in and out of 2-hour-rated enclosure must be firestopped to 2-hour ratings.

J. System shall conform with FCC 47 CFR Part 90.219 Revision 2007 and be listed under UL 2524.

PART 3 - EXECUTION

3.01 FIRE ALARM SYSTEM:

A. The fire alarm system shall be new and furnished with a warranty (parts & labor) of at least one year from the date of beneficial occupancy or final inspection by SCO and Owner. Equipment, initiating devices, and alarm appliances shall be arranged, and the annunciator zones shall be configured as described by this specification.

B. All equipment supplied must be specifically listed for its intended use and shall be installed in accordance with the manufacture’s recommendations. The Contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Contractor shall refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.

C. Do not locate addressable modules in unconditioned spaces.

D. All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.

E. When programming the system, activate the automatic drift compensation feature for all spot type smoke detectors. Systems with alarm verification are not to have this feature activated without written direction from the Owner's representative or the AHJ.

F. Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the Engineer/Owner's rep.

G. Print a complete System Status and Programming Report after the above steps have been done. This must include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector. This documentation shall be provided at the SCO inspection.

I. Provide a documentation cabinet prominently labeled “SYSTEM RECORD DOCUMENTS” adjacent to the fire alarm control panel. Include all record documentation inclusive of as-built floor plans and NFPA 72 Record of Completion forms.

J. fire alarm system assumption of responsibility/liability:

1. Prior to beginning work on the existing fire alarm system the responsibility and liability for the system shall be transferred to the contractor. A signed letter transferring the responsibility of the system as well as an emergency contact list shall be provided to the owner prior to the start of any construction. Coordinate with the Life Safety Shop.

3.02 FIRE ALARM CONTROL EQUIPMENT INSTALLATION

A. The technician who makes final connections and programs the FACP is the "installer" even though most field connections to system devices and appliances are normally made by electrical Contractor personnel. The responsibility for assuring a proper installation overall rests with this individual fire alarm system technician. In addition to doing the final hookups and activating the system, this individual is expected to check the field connections to assure all work is properly done. The absence of system "trouble" signals is not an adequate measure of the field wiring, which could have "T" taps, the wrong type of wire, improper terminations, ground (drain wire) issues, etc.

B. Notification Appliance Circuit booster power supplies must be individually monitored by the FACP and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non- conditioned space. A 24vdc power circuit serving addressable control relays must also be monitored for integrity. All fire alarm power supplies shall have 120-volts surge suppressors.120-volts surge suppressors are to be supervised for integrity with an Addressable Monitor Module.

C. Basic operating instructions shall be framed and permanently mounted at the FACP. In addition, the NFPA 72 "Record of Completion" must be kept at the FACP. All System documentation shall be provided and housed in a Documentation Cabinet at the control panel.

D. Provide an engraved label on outside of the FACP door identifying its 120-vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number. On inside of FACP door, indicate panelboard location.

E. Alarm notification appliances (audible and visible) are to comply with NFPA 72, the North Carolina Building Code, and ANSI 117 criteria for intensity and placement. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern. All strobe lights installed in a single space must be synchronized. Devices can be mounted on the ceiling. Wall mounted devices shall be mounted with the entire lens between 80” minimum and 96” maximum off finished floor.

3.03 SURGE PROTECTION

A. For each AC power circuit that interfaces with fire alarm equipment, install an AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance will improve the effectiveness of the suppressor in clipping fast rise time voltage transients.

B. On DC Circuits Extending Outside Building: Install the surge arrestor in a labeled enclosure near the point of entry to or exit from each building.

3.04 SIGNALING LINE CIRCUITS

A. Provide a minimum of one loop per floor for signaling-line circuits.

B. Unless this specification requires otherwise, outgoing and return loops must be in separate raceways per 2013 NFPA 72. (12.3.7) Provide isolation modules (or isolator bases) along each SLC (addressable loop). 20 devices max between ISO’s.

3.05 AC POWER

A. Systems are to be provided with a separate and independent source of emergency power. Switching to emergency power during alarm shall not cause signal drop-out. Batteries must meet the appropriate NFPA capacity requirements, with a 25% safety factor.

B. The branch circuit breaker(s) supplying the system must be physically protected by a breaker handle lock-on device and each must be identified with a 1/4" permanent red dot applied to handle or exposed body area.

C. Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (SNAC) panel, digital alarm communicator, etc. identifying the panel location, panel name, and breaker number for the 120VAC circuit.

D. The fire alarm system shall monitor 120-VAC power to shunt trip breakers used in conjunction with fire suppression systems. Use an addressable monitor module to accomplish this supervisory function. Provide a breaker handle lock-on device on circuits used for shunt trip power.

3.06 CONDUIT AND WIRING

A. The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides.

B. Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

C. All fire alarm system wiring shall be in metal conduit or surface metal raceway. All fire alarm system raceway, couplers, and connectors must meet the performance and installation requirements of Section 26 05 33 “Raceway and Boxes for Electrical Systems”.

1. Cable size and the requirement to maintain a Class A or Class X loop on all Signaling Line Circuits cause conduit fill to exceed specified maximums for the 1/2" size; therefore, 3/4" raceway should be used.

D. All conduits that penetrate outside walls from air-conditioned space must have internal sealing (duct- seal), to prevent condensation from infiltrating humid air.

E. All wiring shall be color coded. All the circuits in the system shall be wired with AWG 14, minimum, stranded copper, THHN/THWN conductor, installed in metallic conduits. Color Coded wires shall be in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:

1. Initiating Circuits, General ---------- Red (+)/White (-)
2. Initiating Circuits, Smoke Only ---------- Violet (+)/Gray (-)
3. Alarm Indicating Appliance Circuits ---------- Blue (+)/Black
4. AHU Shutdown Circuits ---------- Yellow (+)/Brown
5. Door Control Circuits ----------Orange
6. Elevator Capture Circuits ---------- Brown

F. To minimize wiring fault impact, isolation modules shall be provided in all the locations listed below. If ceiling height ≤10 feet, isolator base type initiating devices are permitted to be used to satisfy any or all the following

1. In or immediately adjacent to the FACP, at each end of the addressable loop. These two isolators must be in the same room and within 15 feet of the FACP.
2. After each 20 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer.

3. For loops with less than 20 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACP).
4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
5. Each isolation module must be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings

G. Detection or alarm circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power must be properly separated by a minimum of .25 inches per NEC, from other circuits, and the enclosure must have an appropriate warning label, to alert service personnel to the potential hazard.

H. Class A or X Circuits Required: Systems with one or more addressable sub-panels that (1) have an integral addressable loop controller, or (2) monitor multiple non-addressable initiation zones, shall comply with the NFPA 72 requirements for Class “A” or “X” circuits for their networking cables.

I. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices will not be permitted. Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

J. All circuits leaving the riser on each floor shall feed through a labeled terminal block in a hinged enclosure accessible from the floor. Terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

K. All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten (10) megohms, as verified with an insulation tester. Provide advanced notice to the Engineer of these tests.

L. The system shall be electrically supervised for open or (+/-) ground fault conditions in SLC, alarm circuits, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

3.07 ADDRESSABLE PULL STATIONS

A. Addressable pull stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except using a key. All pull stations shall be dual action, have a positive, visual indication of operation and utilize a key type reset. Glass-break rods are not allowed. Mount pull station with operating mechanism between 42-inches and 48-inches above finished floor.

3.08 NOTIFICATION DEVICES

A. Both audible and visible alarm signals shall be provided. Visible signals for fire alarm must be the strobe (flash discharge) type, with clear lens, and shall comply with current ADA requirements for intensity and placement.

B. Alarm notification appliance (NAC) circuits shall be NFPA 72 Class B. The load connected to each circuit must not exceed 80% of rated circuit output. The NAC voltage drop during alarm must not exceed 80% of voltage difference between the minimum source voltage and minimum device voltage. To achieve this, the design must consider wire size, length of circuit, device load, inherent voltage loss within the FACP power supply, etc. The Contractor shall use power outage testing to verify that the NAC circuit was designed and installed properly.

C. The location of all end of line devices shall be labeled on the device, with NAC panel number and NAC circuit number, and recorded on the “As-built” drawings. EOL shall not be located more than 12-feet above finished floor.

3.09 DETECTORS

A. Design for most occupancies: Install smoke detectors as shown on the plans.

B. This specification covers only addressable fire alarm systems. Non-addressable, non-analog initiating devices have commonly been called "conventional" detectors. However, since most new systems now utilize analog-addressable smoke detectors, they are the norm (or the "convention" per Webster's). Therefore, the preferred term for those older technology devices is now "non-addressable".

C. Detectors used for elevator: Primary, alternate recall points and the machine room & the shaft shall be indicated on the control Matrix. Elevator capture or control signals shall come from the FACP as relayed by control modules.

D. The FACP and all other control equipment locations, including any transponders, sub-panels, and booster power supplies, must be protected by a spot type smoke detector located within 15 feet of the equipment (measured horizontally).

E. When installed in a room, detectors shall be oriented, so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.

F. Spot-type smoke detectors shall secure the head to the base thru the built-in locking device. For detector mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.

G. Spot-type smoke detectors shall not be used where ceiling height exceeds 25 feet because it makes access for maintenance very difficult and could impede response.

H. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors must be replaced by the Contractor at no additional cost to the Owner. Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and must not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

I. A detector installed where accidental damage or deliberate abuse is expected shall be provided with a guard that is listed for use with it and is acceptable to the AHJ.

J. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #) Show on the as-built plans, and permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For duct detectors, apply the identification to a suitable location on exterior of their housing. Device labels may not be affixed

to the device. Identification labels must be printed labels with black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

K. Addressable Interface Modules (control and monitor modules)

1. Addressable interface modules (used to monitor all contact type initiating devices) must be in a conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.
2. One module may serve as many as 6 heat detectors, in a single space.
3. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., must cause distinct audible and visible indications at the FACP.

3.10 DUCT MOUNTED SMOKE DETECTORS

A. All air duct/plenum detectors must have a Remote Alarm Indicator Light (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration. The numbers of detectors per duct shall be per NFPA 72 requirements based on the size of the air duct, air duct configuration, air speed, and duct manufacture’s installation requirements.

B. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.

C. Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long must be provided with far end support for stability.

1. The preferred method for providing support is to extend the intake tube through the far side of the duct, seal around the tube where it penetrates the duct wall and plug the end with a rubber stopper.

D. Duct smoke detector mounting position are critical for proper operation. The Manufacturer's detailed installation instructions must be followed. The Contractor shall mark the direction of air flow on the duct at each duct detector location.

E. Avoid the use of duct detectors on outside air intakes, as this can lead to nuisance alarms and troubles from moisture and dust.

F. The fire alarm panel output for duct detectors shall be alarms.

3.11 PRINTER

A. An event printer is required for all systems. Provide a 120vac tractor feed printer that uses ordinary (non-thermal) paper. Install in location selected by the Owner (often beside FACP). Connect the printer to a circuit powered by the generator from the same panel powering the FACP.

3.12 AIR HANDLER UNIT (AHU) SHUTDOWN

A. A supervised "AHU Shutdown Defeat" switch must be provided in/adjacent to the FACP or as a key- operated function in the Remote Annunciator. Provide an informative engraved label at the

FACP about this function. The switch must cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position. This is to provide the Owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm will not clear, prior to arrival of the fire alarm service technician, or for testing purposes.

B. All shutdown relays must be directly controlled and monitored by the fire alarm system. The Building Automation System (BAS) shall not be used for life safety functions . Relays should be wired fail safe.

3.13 ANNUNCIATOR

A. Each addressable fire alarm system must include an LED-type "zone" annunciator at (or in) the FACP, or in another location if acceptable to the AHJ. As a minimum, this annunciator is to indicate the specific type of alarm or supervisory signal (smoke detector, water flow, sprinkler valve closed, etc.), for groups of addressable devices. The area ("zone") that is represented by each LED shall not exceed 1 floor or 22,500 square feet and must not cross building fire walls or smoke compartments.

3.14 ALARM VERIFICATION FOR SMOKE DETECTORS

A. The fire alarm system shall be equipped with Alarm Verification.

B. System shall provide as a feature an alternate signal processing algorithm to verify the presence of smoke. The algorithm shall be selectable during system programming. The total effective delay created by the verification algorithm shall not exceed 60 seconds. Do not activate alarm verification unless directed to do so by AHJ, Engineer, or Owner.

3.15 EMERGENCY VOICE/ALARM COMMUNICATIONS

A. Where specified by the Engineer, or required by Code, the system shall have Emergency Voice/Alarm Communications capability. This may include just one or more items, as follows:

1. One-way Emergency Voice-Alarm (PA Type) System.
2. Emergency Voice/Alarm Communications Systems shall be designed for survivability in accordance with NFPA 72.

B. One-way Voice/Alarm (PA) installations shall be dual channel, permitting the transmission of an evacuation signal to one or more zones and simultaneous manual voice paging to other zones, selectively and in any combination. For all buildings, the One-way Voice/Alarm (PA) Communications System, where provided, must meet the following requirements.

1. Each floor, stairway, elevator bank, and Assembly space (>300) is to be a separate communication zone. Speakers are to be spaced to provide required sound levels. Check audio levels in all areas; adjust taps or install additional speakers, if needed. Strobe lights are not to be installed in elevator cars or stairways.
2. Speakers in stairways shall be installed at every third-floor landing, to avoid excessive audio levels and reverberation. Speakers in elevator cars, restrooms, and other very small, confined spaces shall be tapped on very low power levels or, where permitted by the AHJ, muted to reduce sound output.
3. Normal audio amplifier power shall be a minimum of 120% of the system design load, per channel. For purposes of this calculation, use the amplifier's continuous two-tone output rating and the designed power setting of each individual speaker. Provide a copy of this calculation with the shop drawing submittal to the Engineer. Also include on the "calculations" sheet included as part of the as-built drawings.

4. At least one backup amplifier shall be provided for each channel, equal in power to the largest primary amplifier. For systems with distributed amplifiers, provide one backup at each transponder location. Failure of any amplifier shall automatically result in the defective unit being switched off-line and replaced with the backup.
5. The audible emergency evacuation signal shall comply with Notification Devices above. This does not preclude the system from providing additional (non-evacuation) notification signals, including recorded voice messages, for specific emergency situations. Visible alarm notification appliances must also be provided per NC Code and ADA requirements.
6. One-way Voice/Alarm digital audio circuits are to be wired with twisted pair copper conductors (AWG 18 minimum) in jacketed cable, or with fiber optic cable. Analog audio circuits are to be wired with AWG 18 minimum twisted pair copper conductors in shielded cable, Belden 8790, West Penn 293, or equal. Cable jacket color is to be gray, with red (+) and black (-) conductor insulation. For shielded cables, the shield must be continuously connected from the amplifiers to the end of line. Tape the shield splice at each speaker and handset, to insulate from ground. Single point ground the shield at the amplifier or control unit unless prohibited by system manufacturer.
7. Communications equipment shall be housed in the FACP and/or in adjacent cabinets(s) of matching appearance and size. All connections between the FACP and the voice communications panel shall be made via cables or harness assemblies which have been prewired and tested by the system manufacturer.
8. Evacuation signal shall be a "three-pulse" temporal pattern complying with ANSI S3.411990.

3.16 REMOTE ALARM TRANSMISSION REQUIREMENTS

A. Each system with automatic fire detection, or which monitors a sprinkler system, shall be equipped with a 8 zone outboard Digital Alarm Communicator Transmitter (DACT) for transmission of fire alarm, supervisory, and trouble signals to a Central Station, Remote Supervising Station, or Proprietary Supervising Station. DACT shall be cellular type in accordance with NFPA 72. Provide back-up power for signal transmission equipment as required in NFPA 72.

B. The following signals shall be reported as applicable:

1. Fire Alarm
2. Sprinkler Water Flow Alarm
3. Fire Pump Running Alarm as an alarm
4. Fire Pump Abnormal Status Supervisory Signal
5. Sprinkler Valve Tamper (Closed) Supervisory Signal
6. Sprinkler Low Temperature / Air Pressure Supervisory Signal
7. Fire Alarm System AC Power Trouble
8. Duct Detector as an alarm
9. Shunt trip power off as a supervisory alarm

C. Sprinkler and fire pump supervisory signals are permitted to be combined by the DACT, for transmission. Contact the AHJ for more information.

D. The precedence of DACT signals transmitted to the Supervising Station shall be as follows:

1. Fire Alarm
2. Water flow
3. Supervisory Signal
4. Trouble Signal*

E. The Contractor must provide a type of DACT that is compatible with the Owner's alarm receiving equipment, or the Supervising Station selected by the Owner, as applicable. The Contractor must also verify proper signal receipt by the Supervising Station. The transmission means shall comply

with NFPA 72 and campus standard. Keltron radio mesh dialer shall be provided for transmission to campus police department.

3.17 AUTOMATIC SMOKE DOOR AND AUTOMATIC LOCK REQUIREMENTS

A. Wall-mounted magnetic door holders and separate heavy-duty closers shall be used, instead of combination door control units. The electromagnets shall be controlled by the building's smoke detection system FACP. Individual smoke detector auxiliary contacts shall not be used to release door holders.

B. Automatic door locks in the path of egress controlled by the system must be either fail safe magnetic locks or failsafe electro-mechanical with reverse bevel dead bolts.

C. All locked protected doors in the path of egress must immediately unlock upon fire alarm, loss of AC power, disablement of the fire alarm system (defined as loss of 24 VDC power) or upon manual operation of an unlock switch at a constantly attended location.

3.18 SPRINKLER SYSTEM AND OTHER MONITORING

A. The following sprinkler system alarm and supervisory functions shall be provided as a part of the fire alarm system:

1. Water flow alarm, by sprinkler zone (not to exceed one floor).
2. Supervision of each control valve.
3. Supervision of air pressure, both high and low.
4. Supervision of fire pump.
5. Elevator shunt trip power off. Provide breaker clip on circuit breaker used for elevator shunt trip power.

B. Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.

3.19 KITCHEN EXHAUST HOOD EXTINGUISHING SYSTEMS

A. Installation shall comply with the NFPA 72-2013 standard for the type of system installed.

B. System(s) shall be interconnected with the fire alarm system as a separate system address.

C. The exhaust fan must continue running after the system has been discharged, (except on carbon dioxide systems) to remove smoke. The supply fan should stop. All sources of heat for appliances served by the extinguishing system (both electric and/or gas) must be turned off.

D. Provide circuit breaker clip on breaker used for kitchen hood shunt power.

3.20 FIRE ALARM SYSTEM INSTALLATION AND CONFIGURATION

A. Supervision required: The connection between individual addressable modules and their contact type initiating device(s) must be supervised.

B. Floor Plans with Device Numbers: A copy of the floor plans shall be provided at the control panel. A separate sheet shall be provided for each floor. Plans shall be 36” x 24” minimum, laminated and hung on hooks in the fire command center All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line device.

C. Loop 1 shall be assigned to the lowest level devices and loop number shall increase with floor number. Device numbering starts in the same location on each floor and increase accordingly as circuit location increases.

3.21 FIRE AND LIFE SAFETY CRITERIA FOR DOORS CONTROLLED BY FIRE ALARM SYSTEM:

A. For life safety reasons, any exit or exit access doors that are locked to delay egress, in accordance with the NC Building Code, must utilize one of the following types of locking hardware:

1. Magnetic Lock (fail-safe) utilizing a 24vdc magnet and contact plate
2. Electro-Mechanical Lock (fail-safe) with reverse bevel type dead bolt

B. These doors must immediately unlock upon any fire alarm signal, loss of building AC power, disablement of the fire alarm system (defined as loss of its 24vdc power), or upon manual operation of an unlock switch at a constantly attended location.

C. Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching

D. Smoke doors to be held open shall be powered by 24vdc wall/floor-mounted magnets on auxiliary fire alarm circuits and released upon alarm. The system must be programmed to drop the door hold-open magnet load within 60 seconds after loss of 120vac power

E. Wall-mounted magnetic door holders and separate heavy-duty closers shall be used for control of smoke doors instead of combination frame-mounted units that include an integral smoke detector and control mechanism.

F. Contact the AHJ for guidance on programming the fire alarm system to determine which fire alarm initiation devices should cause release of these doors. The FACP should have a supervised door holder bypass switch to avoid nuisance drops during routine system maintenance operations.

3.22 SYSTEM DOCUMENTATION, TRAINING, AND MAINTENANCE

A. Maintenance: The manufacturer, or authorized distributor, must maintain software version (VER) records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.

B. System Report In addition to the Shop Drawing submittal described elsewhere, the fire alarm system Contractor shall provide the Engineer two bound copies of the following technical information, for transmittal to the Owner:

1. As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
2. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
3. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
4. Manufacturer detailed maintenance requirement.
5. Technical literature on all control equipment, isolation modules, power supplies, batteries, detectors, manual stations, alarm/supervisory signal initiating devices, alarm notification appliances, relays, remote alarm transmission means, etc.
6. The as-built "calculations" sheet.

C. Electronic archive: Complete configuration data (site-specific programming) for the system must be stored on USB drive and archived by the fire alarm system manufacturer or authorized

distributor. A USB drive of this data shall be submitted to the Engineer for transmission to the Owner on the day the system is commissioned. A copy of this site-specific data base shall also be placed in the Documentation Cabinet.

D. The Contractor shall provide the Owner with one copy of the following:

1. All software required for the installed fire alarm system.
2. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described above.
3. Framed floor plans mounted at the FACP: Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator. As-built room numbers shall match the signage in the building.
4. Interconnection cable where such is required to connect the fire alarm system to a PC.

E. The manufacturer's authorized representative must instruct the Owner's designated employees in operation of the system, and in all required periodic maintenance. A minimum of 8 hours on-site time will be allocated for this purpose and, for those facilities operating on a 24-hour basis one additional hour of instruction will be individually provided for the 2nd and 3rd shift. Two copies of a written, bound summary will be provided, for future reference.

1. Some facilities require more in-depth training. Check to verify needs and requirements.
2. Scheduling of training must be arranged to meet the Owner’s schedule. Additional training shall be available at a cost to be mutually agreed upon by the Owner and the Contractor.
3. Training shall be in the Owner’s provided classroom.
4. The training may not be waived, deleted or reduced in the number of hours required.
5. Training shall cover as minimum the following topics:

    a. Preventive maintenance service techniques and schedules, including historical data trending of alarm and trouble records.
    b. Overall system concepts, capabilities, and functions. Training shall be in depth, so that the Owner shall be able to take any device out of service and return any device to service without need of Manufacturer’s approval or assistance.
    c. Explanation of all control functions, including training to program and operate the system software.
    d. Methods and means of troubleshooting and replacement of all field wiring devices.
    e. Methods and procedures for troubleshooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry and interconnections.
    f. Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of training for the Owner’s use in the future.

F. The University maintains and services all fire alarm equipment on campus. The contractor shall provide factory training, all software, and license agreements necessary for the University to have the capability to develop a database and any operating scenario for the buildings fire alarm system without permission from outside distributors. This arrangement shall recognize the University as a trained and licensed Fire Alarm System installer independent of local distributors. Any cost to the University including training hours required by the manufacturer above and beyond what is required in these Guidelines shall be included as alternate bid.

G. The Owner shall be trained to perform all NFPA 72 required maintenance. The training shall include both demonstration and supervision of a “hands-on” replacement of heads. Panel modifications required to take detector heads out of service and return them to service shall be “hands-on” training session. The training shall be in a minimum of two 4-hour sessions provided on separate days. The schedule shall be coordinated with the Owner. A written competency test

must be submitted to the Engineer and to the Owner as a sample prior to using the written competency test at the site. A written description of a hands-on test shall be provided to the Engineer and Owner for review prior to using the test at the site. As a minimum the following tests shall occur during certification of the Owner's employee.

3.23 SPARE PARTS

A. The following spare parts shall be provided with the system. For multi-building projects, calculate quantities separately for each building that contains a dedicated fire alarm control panel. Increase decimal quantities to the next higher whole number

1. Fuses.....2 of each size in system
2. Manual Fire Alarm Boxes.....2% of installed quantity
3. Addressable Control Relays.....4% of installed quantity
4. Notification Devices.....4% of installed quantity
5. Monitor/Relay Modules (Addressable Interface)……....4% of installed quantity
6. Isolation Modules / Isolation Bases.....4% of installed quantity
7. Addressable, Electronic Heat Detectors/Bases.....6% of installed quantity
8. Spot-Type Smoke Detectors/Bases.....6% of installed quantity
9. Air Sampling Detectors……..5 Years of filters
10. Duct Smoke Detectors/Bases.....6% of installed quantity

3.24 SYSTEM TESTING & CERTIFICATION

A. Upon completion of the installation the Contractor and the Manufacturer's authorized installer and designer together shall conduct a 100% performance test of every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Contractor shall be present for the full 100% test. The person responsible for programming the system must be present.

B. The Engineer and Owner must be given 7 days' notice of the tests. All Audio-Visual Device Testing shall be scheduled with the Owner.

C. 100% Test: The manufacturer or authorized distributor (by definition, "installer") must 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation must be part of the "System Status and Programming Report". Provide an alarm and trouble history printout at the SCO inspection, documenting this 100% test.

1. Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system Contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The Engineer shall witness these tests in order to sign the NFPA 72 Record of Completion as the AHJ. The Engineer shall fill out the SCO Fire Alarm Systems Checklist and provide this document at the SCO inspection. This can be found at http://www.ncsco.com
2. If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon water flow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable water flow switch(es), or from any two smoke detectors in the selected spaces (AND gate)

3. The digital communicator shall be on-line and tested for proper communication to the receiving station.
4. All supervised circuits must also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)
5. All testing described above shall be repeated if subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.
6. The contractor and Engineer shall verify the voltage drop of each NAC circuit by testing and recording the voltage at the origin and at the EOL for each NAC circuit, under battery power only. Prior to conducting these tests, the Contractor shall verify the candela settings of all strobes. Provide documentation of these tests at the SCO final inspection.

D. Test Documentation: The installer must fill out and submit the following documentation to the Owner, through the Engineer, prior to the AHJ's system acceptance inspection:

1. Written verification that this 100% system test was done with copy of print out generated during test.
2. The NFPA 72, "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and to certify that: (a.) It was done per Code, and (b.) The Code required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) must sign this form. If a representative of the AHJ, Owner, or Engineer witnesses the tests, in whole or in part, they must also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
3. The System Status and Programming Report described in NFPA 72. This must be generated on the day of the system acceptance inspection and shall include the measured sensitivity of each smoke detector.

E. After completion of the 100% system test and submission of documentation as described above the installer is to request the Engineer to set up an inspection. The system must operate for at least two days prior to this inspection. The responding Fire Department shall be notified of this, for pre- fire planning purposes. On local government projects, local fire authorities may also want to participate in system acceptance inspections. However, for State-owned property they have no inspection jurisdiction and, if present, are only to observe.

3.25 PRE -FINAL INSPECTION

A. At the Owner’s request and after passing the Engineer’s pre-final inspection, the Contractor and Manufacturer’s authorized installer will conduct system test in the presence of the Owner and the Engineer.

3.26 CONTRACTOR/INSTALLER TESTING AND CERTIFICATION

A. Upon successful completion of the Pre-final Inspection, per the NCDoI checklist, and correction of all deficiencies, the manufacturer’s authorized representative shall issue a test report to: the A/E, the Facilities Services Life Safety Shop, and the UNC Health and Safety Oficer detailing and certifying the test, including those requirements as specified in this document.

3.27 A/E TESTING AND CERTIFICATION

A. Upon successful completion of inspection and testing by the A/E the contractor shall provide the following to the A/E and UNC Construction Management to schedule the Facilities Services Life Safety Shop owner acceptance commissioning inspection and test.

1. The latest copy of Detector Sensitivity Report.
2. A printout of the current installed site-specific database.

3. Signe copy of the NFPA “Record of Completion” form per NFPA 72.
4. Signed copy of the NCDoI checklist.
5. Current copy of as-built drawings with correct room numbers and device system addresses.
6. Copy of battery calculations.
7. Copy of record for the Notification Appliance Circuit voltage measurements taken at the EOL devices during the A/E test. Take readings at the start of the test and every 15 minutes during the NAC test. Test shall be 30 minutes minimum. Test shall be conducted with AC power off and under battery power only.

3.28 OWNER TESTING AND INSPECTION

A. Database and Drawing Inspection: Provide all of the above documentation to the Facilities Services Life Safety Shop a minimum of 3 days prior to scheduling on-site testing.
    1) Upon completion of the system databases and drawing review any discrepancies will be documented and forwarded to UNC Construction Management requiring action and corrections from the A/E’s system installer/programmer. When the required actions and corrections have been addressed and performed a corrected printout of the installed site-specific databases and drawings shall be forwarded to the Life Safety Shop for re-review. After review and satisfaction that the corrections have been made the Life Safety Shop will schedule their field inspection and test. The Life Safety Shop will notify the UNC Construction Management of the scheduled date and time.

B. Owner acceptance commissioning field inspection: A 100% fully functional test of all aspects of the system will be conducted. Therefore, it is expected that the system shall be complete in all aspects. Each function and aspect of the system will be tested along with each and every initiating device. Also, all other systems shall be verified, including but not limited to elevator capture features, control of HVAC systems, door locks, fire or smoke doors/dampers, sprinkler systems, etc. The trades’ personnel representing the various aspects must be present. The fire alarm vendor’s technician who programmed the system must be present.
    1. Upon completion of the acceptance commissioning field inspection and test, the Facilities Services Life Safety Shop will forward a list of discrepancies in the form of a formal “Punch List” to UNC Construction Management for comment and/or inclusion in the A/E’s punch-list of items requiring action and/or corrections from the effected systems contractors/installer. Once the contractors/installers have corrected these items, the A/E shall notify UNC Construction Management and schedule a re-inspection by the Facilities Services Life Safety Shop. When the systems are verified to be satisfactory by the Life Safety Shop, the A/E shall be notified by UNC Construction Management to schedule an inspection and test with the Office of State Construction. On or before the day of the Office of State Construction inspection the following must be completed and/or provided to the Owner:
        a. Copy of current databases installed in the system on USB drive.
        b. All drawings shall be posted.
        c. All spare parts and test equipment as described in the specification shall be turned over to the owner.
        d. All training requirements shall be met or scheduled.
        e. All required software shall be turned over to the owner.
        f. All certifications.

g. A new signed and dated NFPA “Record of Completion” form per NFPA 72, signed by the contractor the Designer/Engineer of Record and/or the Construction Management Representative.

h. The FACP shall be turned on but not reporting to the UNC Central Alarm Receiving System.

3.29 FINAL INSPECTION

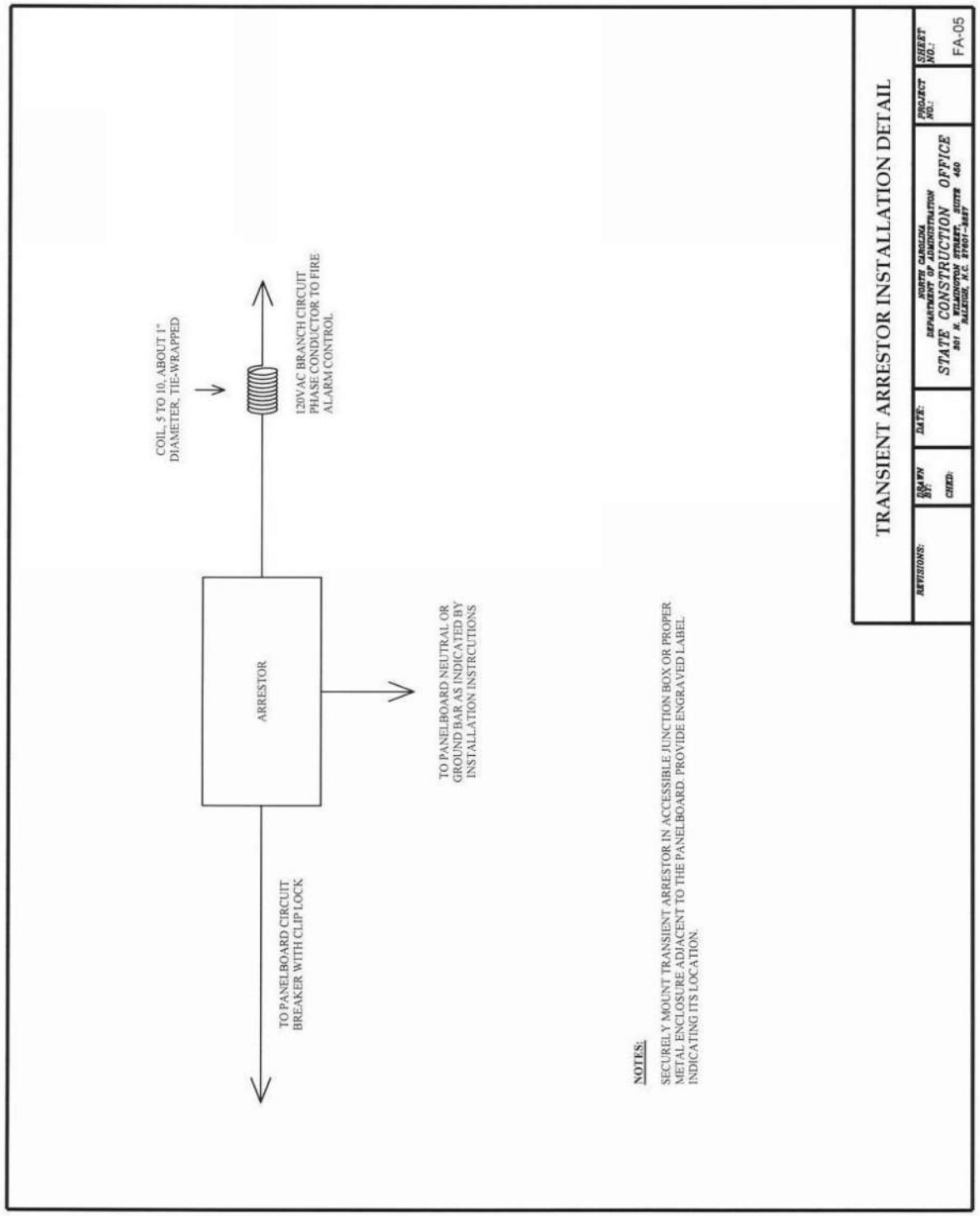
A. The fire alarm system will be inspected, with portions of it functionally tested. This will normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off premises supervising station. Operation of any smoke removal system will be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the Contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical Contractor shall provide two-way radios, ladders, keys for resetting elevators and other equipment, and any other materials needed for testing the system, including a suitable smoke source. The Fire Alarm Contractor’s technician that programmed the system, shall be present on the day of the SCO inspection(s).

1. The test will be conducted entirely by the Contractor. A copy of the final database software must be presented to the Owner before this test. The software shall be loaded from these disks into the system in the presence of the Owner. The review will then be conducted using this software. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again.

   a. In the event of malfunctions or excessive nuisance alarms, the Contractor must take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections.

   b. Test Report: Upon successful completion of the Inspection and after the correction of all deficiencies, the manufacturer’s authorized representative shall issue a test report to the Engineer and Owner, detailing and certifying the test.

   c. System Acceptance: After successful completion of the Final Inspection and recommendation of the Engineer, the system will be accepted by the Owner. At this time the warranty period begins.



END OF SECTION

SECTION 31 10 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Standards set forth by the North Carolina Department of Environmental Quality (NCDEQ) Division of Energy, Mineral and Land Resources.

1.2 SUMMARY

A. This Section includes the following:

1. Removal of trees and other vegetation.
2. Clearing and grubbing.
3. Removing above-grade improvements.
4. Removing below-grade improvements.

B. Related Sections:

1. Division 31 Section “Earth Moving".
2. Division 31 Section "Erosion Controls".

1.3 PROJECT CONDITIONS

A. Traffic: Conduct site-clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.

1. Protect improvements on adjoining properties and on Owner's property.
2. Restore damaged improvements to their original condition, as acceptable to property owners.
3. All erosion control measures shall be in place prior to commencement of clearing operations.

C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
2. Provide protection for roots over 1-1/2 inch (38 mm) in diameter that are cut during construction operations. Coat cut faces with an emulsified asphalt or other acceptable coating formulated to use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
3. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations in a manner acceptable to Engineer. Employ a licensed arborist to repair damage to trees and shrubs.

4. Replace trees that cannot be repaired and restored to full-growth status, as determined by arborist.

D. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated or directed.

1.4 EXISTING SERVICES

A. General: Indicated locations are approximate; determine exact locations before commencing Work.

B. Arrange and pay for disconnecting, removing, capping, and plugging utility services. Notify affected utility companies in advance and obtain approval before starting this Work.

C. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

1.5 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 2 – PRODUCTS

None Used.

PART 3 – EXECUTION

3.1 SITE CLEARING

A. General: Remove trees, shrubs, grass, and other vegetation, improvements, or obstructions, as required, to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. Removal includes digging out and off-site removal of stumps and roots.

1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
2. Existing trees within clearing limits may be chipped and stockpiled on-site but shall NOT be used as landscaping mulch or fill.

B. Clearing and Grubbing: Clear site of trees, shrubs, and other vegetation, except for those indicated to be left standing.

1. Completely remove stumps, roots, and other debris protruding through ground surface.
2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
3. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

a. Place fill material in horizontal layers not exceeding 6 inches (150 mm) loose depth, and thoroughly compact each layer to a density equal to adjacent original ground.

C. Topsoil Stripping: Strip and stockpile existing topsoil within construction limits for re-spreading. Should the Contractor elect to remove topsoil from the site, suitable topsoil from off-site sources shall be provided for re-spreading at no cost to the Owner.

1. Remove sod and grass before stripping topsoil.
2. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials. All surface topsoil, regardless of thickness encountered, shall not be considered Unsuitable Soil.
3. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
4. Stockpile topsoil materials within construction limits and away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
5. Do not stockpile topsoil within tree protection zones.
6. Dispose of excess topsoil off-site.

D. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.

1. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical drawings and is included under work of related Division 22 Sections. Removing abandoned underground piping or conduits interfering with construction is included under this section.

3.2 DEMOLITION PREPARATION

A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations or as shown on the drawings.

B. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around selective site demolition area.

1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction or as shown on the plans.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary weather protection, during interval between demolition and removal of existing construction, on exterior surfaces and new construction to ensure that no water leakage or damage occurs to structure or interior areas.

C. Provide and maintain exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of building to be selectively demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

D. Protect trees, fences, poles, mailboxes, and all other property unless their removal is authorized. Any property damaged, that is not authorized for removal, shall be restored or replaced to the Owner’s satisfaction.

3.3 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during selective site demolition operations.

1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.

a. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.

B. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving building to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies.
2. Where utility services are required to be removed, relocated, or abandoned, provide bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.

C. Utility Requirements: Refer also to Division 15, 16 and 33 Sections for additional requirements for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start selective site demolition work until utility disconnecting and sealing have been completed and verified in writing.

D. Utility Adjustments and Relocations: Adjust locations, elevations and routes of existing utility lines, poles, guys, vaults, handholes, boxes, and other related appurtenances as required to facilitate new construction. Coordinate adjustments and relocations with utility companies.

3.4 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective site demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.5 SELECTIVE SITE DEMOLITION

A. Demolish and remove existing construction only to the extent required by new construction and as indicated on the drawings. Use methods required to complete Work within limitations of governing regulations.

1. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
2. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.

3. Comply with all applicable regulations during demolition, handling and disposal of all items indicated to be removed or necessary to be removed to allow construction of new work.

B. Demolish asphalt, concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.

C. Remove sawcut concrete and asphalt, including aggregate base, to a depth of 12-inches below existing, adjacent grade, or as indicated. Provide neat sawcut at limits of pavement removal as indicated.

3.6 PATCHING AND REPAIRS

A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective site demolition operations.

B. Where repairs to existing surfaces are required, match previous work as closely as possible.

1. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to manufacturer's printed recommendations.

C. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.

3.7 CLEANING

A. Keep the site free from debris and hazards and inspect the site at the end of each day for trash. All adjacent roads and drives outside of the construction fencing shall remain in operation during construction and shall remain free of all construction materials and debris.

3.8 DISPOSAL OF WASTE MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning on Owner's Property: Burning is not permitted on Owner's property.

C. Removal from Owner's Property: Remove waste materials and unsuitable or excess soils and mulch from Owner's property. Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION

SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Report of Subsurface Investigation.

1. The geotechnical report is available to bidders as general information with regard to project and site conditions. However, the geotechnical report is not a part of the contract documents and is not a warranty or guarantee of subsurface conditions. Variations in subsurface conditions should be anticipated. Bidders should carefully inspect the site prior to bidding and will be provided reasonable access to perform independent explorations of subsurface conditions, if requested.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing and grading subgrades for walks, lawn areas, and landscaping.
2. Excavating, filling and backfilling for structures.
3. Base course for walks and pavements.
4. Subsurface drainage backfill for trenches.
5. Excavating and backfilling trenches.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 01 Sections for allowances, definitions and procedures.
2. Division 31 Section "Site Preparation" for site stripping, grubbing, topsoil removal, and tree protection.
3. Division 31 “Erosion and Sediment Controls”, for all areas of the site that are graded or disturbed by any construction operations.
4. Division 32 Section "Planting" for finish grading, including placing and preparing topsoil for permanent and temporary grass seeding.
5. Division 33 Section “Storm Drainage Utilities” for storm drainage.

1.3 UNIT PRICES

A. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following:

1. 24 inches outside of concrete forms other than at footings.
2. 12 inches outside of concrete forms at footings.
3. 6 inches outside of minimum required dimensions of concrete cast against grade.
4. 6 inches beneath bottom of concrete slabs on grade.
5. 6 inches beneath invert elevation of pipe in trenches and 12 inches wider than pipe outside diameter.
6. Additional rock removed beyond the limits outlined above to accommodate trench boxes, other removal methods, compaction equipment or other reasons shall not be included in the payment volume.
7. Any materials paid by Unit Prices to replace excavated rock shall utilize these same measurement limits.

B. Unsuitable Soil Measurement: Volume of soil actually removed, measured in original position, but not to exceed the limits directed by the Owner's Independent Testing Agency.

1. Additional soil excavated beyond the limits directed by the Owner's Independent Testing Agency; including lay-back of excavation walls, excavation to accommodate trench boxes or other shoring, etc.; shall not be considered Unsuitable Soil.

C. Replacement Material Measurement: Volume exactly equal to that of the unsuitable soil or rock that was removed, measured in original position.

D. Unit prices for unsuitable soil and rock removal shall include all work and materials as defined in Division 01 sections.

1.4 DEFINITIONS

A. Excavation consists of the removal of material encountered to subgrade elevations and the reuse or disposal of materials removed. Refer to the following section for additional definitions of classified excavations.

B. Subgrade: The uppermost surface of an excavation or the top surface of a fill or backfill immediately below base course, drainage fill, or topsoil materials.

C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.

D. Surface Course: The top layer of the pavement structure placed on base course or subgrade.

E. Base Course: Layer placed between the subgrade elevation and asphalt paving courses.

F. Bedding Course: Layer placed over excavated subgrade in a trench before laying pipe.

G. Unauthorized excavation consists of removing materials beyond indicated subgrade elevations or dimensions without direction by the Architect. Unauthorized excavation, as well as remedial work directed by the Architect, shall be at the Contractor's expense.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.

I. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within building lines.

1.5 EXCAVATION CLASSIFICATIONS

A. Excavation Classifications: All excavation is classified as General Excavation except for Rock and Unsuitable Soil Materials as defined in this section.

1. General Excavation: Excavation, removal and/or disposal of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and/or removed; together with soil, boulders, and other materials encountered that are not classified as rock, unsuitable soil, or unauthorized excavation.

a. Intermittent drilling, blasting, or ripping to increase production and not necessary to permit excavation of material encountered will be considered general excavation.

b. Soil (regardless of nature) or other debris encountered above proposed subgrade elevations shall be considered general excavation unless determined by the Architect to meet the definition of rock.

2. Unsuitable Soil Excavation: Removal and disposal of soil materials or other debris encountered below proposed subgrade elevations which is deemed unsuitable to remain in place by the Architect or Owner's Independent Testing Agency.

   a. Soil and/or other debris encountered above proposed subgrade elevations shall be considered general excavation.
   b. Soil material which, in the opinion of the Architect or Owner's independent testing agency, can be repaired by scarifying, drying and recompacting or material which is made unsuitable by delay of work, lack of protection or other actions of the Contractor or his Sub-Contractors shall not be considered as unsuitable soil and shall be repaired or replaced by the Contractor at no additional cost to the Owner. Moisture content alone shall not be the determining factor as to the presence of unsuitable soil.
   c. Any material moved or removed without the measurement by the Owner's independent testing agency and approval by the Architect will be considered as general excavation.
   d. Surface topsoil, regardless of thickness encountered, shall not be considered unsuitable soil.
   e. Stones, rocks and boulders not meeting classifications of rock shall not be considered unsuitable soil. Stones, rocks and boulders shall be removed from soil as necessary if soil is to be used as fill or backfill. Removed stones, rocks and boulders shall be removed from the site.
   f. The unsuitable soil allowances shall be for unsuitable soils only and not for repair of weather-related deterioration of subgrade. These Allowances are not for required on-site cut and off-site fill necessary to bring subgrades and grades to elevations shown on drawings. Contractor shall be responsible for proper drying and dewatering procedures, as necessary, as part of his normal operations.

3. Rock Excavation: Removal of rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1.0-cu.yd. that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted. In the event rock (as defined above) is encountered, the Contractor shall immediately notify the Architect.

   a. Rock excavation equipment: Late-model, track mounted CAT 330 or equivalent hydraulic excavator equipped with a narrow (36" max) bucket with new rock teeth and operating at the highest normal operating RPM. The Contractor shall provide equipment specification and test data verifying that the equipment to be used for demonstration purposes complies with the minimum requirements. The equipment shall be in good repair and in proper working condition. The Owner reserves the right to inspect and approve the equipment to be used for demonstration purposes. Rock is defined as material which, after 1 hour of continuous digging using the equipment described above, removes less than 10 cubic yards of material.

4. Classified excavation requirements:

   a. Contractor shall expose and clean the rock material for inspection and measurement by the Architect.
   b. Do not excavate rock or unsuitable soil until it has been classified and cross-sectioned by the Owner's independent testing agency or Architect. Any material

moved or removed without the measurement by the Owner's independent testing agency and approval by the Architect will be considered as General Excavation.

c. The Architect shall be the final judge on what is classified as unsuitable or rock excavation.

d. The contractor may be required to provide equipment specification data verifying that the above minimum-rated equipment will be used for demonstration purposes. The equipment shall be in good repair and in proper working condition.

e. Rippable rock, weathered rock or overburden which is not classified as rock according to the above definitions shall be considered General Excavation.

1.6 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Test Reports: In addition to test reports required under field quality control, submit the following:

1. Laboratory analysis of each soil material proposed for fill and backfill from on-site and borrow sources.
2. One optimum moisture-maximum density curve for each soil material.
3. Reports of all laboratory and field tests including evaluations of subgrades and foundation bearing conditions.
4. As-built survey of athletic fields, courts and tracks demonstrating compliance with specified tolerances.
5. Reports of Special Inspections.

C. Blasting plan approved by authorities having jurisdiction if applicable due to on-site rock.

D. Report of rock or unsuitable soil removal with quantities confirmed in writing by the Architect or Owner's independent testing agency.

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction. Any earthwork required for preparation of parking areas and drives shall comply with current NCDOT Standard Specifications as per the North Carolina Construction Manual.

B. Comply with applicable requirements of NFPA 495--Explosive Materials Code.

C. Testing and Inspection Service: Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soils to verify that soils comply with specified requirements and to perform required field and laboratory testing.

D. Special Inspections: Owner will employ a qualified Special Inspector or Special Inspection Agency to perform verification and inspection of earthwork construction in accordance with NC State Building Code.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1

1. Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, consultants, Geotechnical Engineer, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3

working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.8 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by the Architect and then only after acceptable temporary utility services have been provided.

1. Provide a minimum 48-hours' notice to the Architect and receive written notice to proceed before interrupting any utility.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shutoff services if lines are active.

1.9 PAYMENT

A. General Excavation: All general excavation to the lines and grades indicated on the drawings including all necessary off-site disposal of excess materials and/or off-site borrow of fill materials shall be included in the base bid.

1. No statement is made or implied that the on-site grading and earthwork indicated on the drawings is balanced.

B. Unsuitable Soil Material Excavation: Unsuitable soil material excavation will be paid by unit prices included in the Contract Documents.

1. Unused amounts of monies included under allowances shall be credited to the Owner by deduct change order.

C. Rock Excavation: Rock excavation will be paid by unit prices included in the Contract Documents.

1. Unused amounts of monies included under allowances shall be credited to the Owner by deduct change order.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide approved borrow soil materials from off-site when sufficient approved soil materials are not available from excavations.

B. Satisfactory Soil Materials: ASTM D 2487 soil classification groups GW, GC, GP, GM, ML, CL, SW, SP, SC, and SM; free of rock or gravel larger than 2 inches (50 mm) in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter. Additionally, satisfactory soil for use in structural fill areas shall meet the following:

1. Have a Plasticity Index of 20 or less and a Liquid Limit of 50 or less.
2. Shall have a Standard Proctor Maximum Dry Density of 90-lb/cf or greater.
3. Satisfactory soil materials obtained from off-site borrow sources shall meet all requirements listed above and possess a Standard Proctor Maximum Dry Density of 90-lb/cf or greater, shall contain at least 20% fines, and have a Plasticity Index of less than 20.

C. Unsatisfactory Soil Materials: ASTM D 2487 soil classification groups MH, CH, OL, OH, and PT. Soils having a Plasticity Index greater than 20 and a Liquid Limit greater than 50 are also unsatisfactory within structural (pavement and building) areas except if placed as specified above.

D. Unsuitable Soil: Refer to paragraph 1.5 of this Section.

E. Backfill and Fill Materials: Satisfactory soil materials.

2.2 PROCESSED AGGREGATE MATERIALS

A. Base Course Material: Type A aggregate base course meeting the requirements of Section 520 of NCDOT "Standard Specifications for Roads and Structures."

B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Bedding Material: #57 washed stone.

D. Drainage Fill: #57 washed stone.

E. Filtering Material: #57 washed stone.

2.3 LEAN CONCRETE FILL

A. Lean concrete fill shall consist of a mixture of portland cement, aggregate and water. Water reducing and air-entraining admixtures may be added at the option of the Contractor.

1. Material shall comply with the requirements of Division 03 Section, Cast-in-Place Concrete.
2. The proportions of the mix shall be determined by the Contractor to obtain a compressive strength of 700-psi at 7-days.

2.4 FLOWABLE FILL - EXCAVATABLE

A. Excavatable flowable fill shall consist of a lean concrete mixture of portland cement, aggregate and water. Water reducing and air-entraining admixtures may be added at the option of the Contractor.

1. Material shall comply with the requirements of Division 03 Section, Cast-in-Place Concrete and NCDOT Section 1000-4.
2. The proportions of the mix shall be determined by the Contractor to obtain a max. compressive strength of 150-psi at 56-days.

2.5 ACCESSORIES

A. Drainage (Filter) Fabric: Woven monofilament filtration geotextile, specifically manufactured as a drainage geotextile; made from polypropylene yarns; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods.

1. Tensile Strength: 200 lb; ASTM D 4632.
2. Tear Strength: 60 lb; ASTM D 4533.
3. CBR Puncture: 700 lb; ASTM D 6241.
4. Water Flow Rate: 18 gpm per sq. ft.; ASTM D 4491.
5. Apparent Opening Size: No. 70; ASTM D 4751

6. Percent Open Area: 4%; CW-02215

B. Separation/Stabilization Fabric: Woven geotextile, specifically manufactured for use as a separation and or stabilization geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 200 lbf (890 N); ASTM D 4632.
2. Tear Strength: 75 lbf (333 N); ASTM D 4533.
3. Puncture Resistance: 90 lbf (400 N); ASTM D 4833.
4. Water Flow Rate: 4 gpm per sq. ft. (2.7 L/s per sq. m); ASTM D 4491.
5. Apparent Opening Size: No. 30 (0.6 mm); ASTM D 4751.

C. Biaxial Geogrid: Integrally formed biaxial geogrid, specifically manufactured for use as a base reinforcement for subgrade improvement. Tensar BX1100, Mirafi BXG-110, or approved equal with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

1. Aperture Dimensions: 1-in (25-mm) nominal.
2. Minimum Rib Thickness: 0.03-in (0.76-mm) nominal.
3. Tensile Strength @ 2% Strain: 280-lb/ft (4.1 kN/m); ASTM D-6637.
4. Tensile Strength @ 5% Strain: 580-lb/ft (8.5 kN/m); ASTM D-6637.
5. Ultimate Tensile Strength: 850-lb/ft (12.4 kN/m); ASTM D-6637.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Site Maintenance: The Contractor shall be responsible to take whatever measures are necessary to ensure reasonable accessibility to and on the construction site so that undue delays are avoided under normal weather conditions. These measures shall include, but not be limited to, the following:

1. Maintaining the surface of the soils in a manner to promote drainage runoff and avoid ponding of water, especially prior to predicted rain events.
2. Avoiding operation of temporary water sources or hoses in a manner which will cause unnecessary and repeated wetting of the site.
3. Fill in severely rutted areas which are ponding water during the construction activities or after rain events with drainage fill material to assist drying and allow construction activities to continue.
4. Provide drying of surface soils and soils intended for filling or backfilling as required to promote accelerated drying of those materials.
5. After successful drying efforts or prior to predicted rain events, grade the areas back to a smooth condition to promote drainage runoff.
6. Controlling vehicular traffic, both construction and personal on the site in a manner to prevent undue damage to soils whenever possible and practical.

7. Providing temporary staging areas of crushed stone or other materials around the construction site which will better withstand the weather and traffic and keep the site accessible immediately or shortly after rain events.
8. Provide de-watering equipment for any areas collecting water which may affect construction or soil densities under built areas.
9. Any claims for weather related delays considered shall be considered with particular attention paid to the Contractor's efforts in regard to the above requirements

3.2 DEWATERING

A. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.

C. Design, furnish, install, test, operate, monitor, and maintain temporary dewatering systems of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls as needed.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
3. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
4. Prevent surface water from entering excavations by grading, dikes, or other means.
5. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
6. Remove dewatering system when no longer required for construction.

D. Soft wet soils, if present at the surface, shall be dried and compacted in place by the Contractor and be stable under proofrolling prior to placing fill. Drying shall be accomplished by discing, plowing or other means necessary and shall be included in the Contractor’s bid. Site soils are typical of the area and susceptible to loss of strength if they become wet, resulting in softening and rutting during construction. Site soils are extremely moisture sensitive, therefore, the Contractor shall take active and aggressive steps to dry soil materials wet of optimum to maintain construction progress through the work and to maintain access to and around the construction. The Contractor, at his option and cost may remove unstable, wet materials and replace with available fill materials in lieu of accomplishing soil drying procedures.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 STABILITY OF EXCAVATIONS

A. Comply with local codes, ordinances, and requirements of authorities having jurisdiction to maintain stable excavations. Contractor is responsible for ensuring all excavation operations and other construction comply with applicable OSHA requirements. Contractor shall provide temporary shoring and bracing as needed to construct the proposed improvements and comply with the above requirements.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

B. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated slopes, lines, depths, and invert elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: As indicated

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove stones and sharp objects to avoid point loading.

1. For pipes or conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
3. Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches (150 mm) below invert elevation to receive bedding course.

3.8 APPROVAL OF SUBGRADE PRIOR TO PLACING FILL OR OTHER IMPROVEMENTS

A. Notify Architect or Owner’s independent testing agency when excavations have reached required subgrade.

B. After stripping is complete the exposed subgrade shall be proofrolled with a fully loaded dual wheel tandem axle dump truck or similar construction equipment. Four passes shall be made in each orthogonal direction. The proofrolling operation shall be observed by the Architect or

Owner's independent testing agency. Should any area fail to tighten up after proofrolling and continue to rut and/or pump, the soil shall be scarified and moistened or aerated and recompacted. Repeat proofrolling operations.

C. When Architect or Owner's independent testing agency determines that unforeseen unsuitable soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Unforeseen additional excavation and replacement with suitable material approved by the Architect will be considered unsuitable material and will be paid by unit prices included in the Contract Documents. Refer to Division 1 Sections.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect. Install french drains at design subgrade if directed by the Owner's independent testing agency and approved by the Architect.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to the Architect.

1. Fill unauthorized excavations under other construction as directed by the Architect or the Owner's independent testing agency.

B. Where indicated widths of utility trenches are exceeded, provide stronger pipe, or special installation procedures, as required by the Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Backfill excavations promptly, but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, damp-proofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Testing, inspecting, and approval of underground utilities.
4. Concrete formwork removal.
5. Removal of trash and debris from excavation.
6. Removal of temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
8. Removal of objectionable materials, including rocks larger than acceptable size, from backfill soils.

B. Backfill retaining walls with the following additional requirements:

1. Backfill materials shall be moisture conditioned as needed to within 2% of optimum prior to placement and compaction.
2. Materials shall be placed in loose lifts not exceeding 8 inches and shall be compacted to not less than 95% of the standard Proctor maximum dry density.
3. All backfill of segmental retaining walls shall be monitored by the Owner's Independent Testing Agency.

3.12 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Pipe sleeves and concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches (450 mm) of footings. Place concrete to level of bottom of footings. Contact the Architect or the Owner's independent testing agency to coordinate details, procedures and possible alternatives.

C. Provide 4 inch (100 mm) thick concrete base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installation and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway base course.

D. Place and compact initial backfill of satisfactory soil material or base course material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.

1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

E. Coordinate backfilling with utilities testing.

F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.

G. Place and compact final backfill of satisfactory soil material to final subgrade.

H. Install detectable warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.13 FILL

A. Preparation: Remove vegetation, topsoil, debris, wet, frozen, and unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placing fills.

1. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.

B. Obtain approval of subgrade as specified prior to placing fill.

C. Obtain approval of fill materials. Remove all objectionable materials, including stones larger than acceptable size, from fill materials.

D. Place fill material in layers to required subgrade elevations for each location listed below.

1. Under grass, use satisfactory excavated or borrow soil material.

2. Under walks, pavements, buildings and other structural areas use base course material, or satisfactory excavated or borrow soil material.
3. Pond embankments, use impervious fill for core/cut-off trench and suitable soil for remainder of embankment.

E. Following placement of fill the subgrade of building and pavement areas shall be proofrolled as described in the Field Quality Control section. The proofrolling operation shall be observed by the Owner's testing agency. Should any area fail to tighten up after proofrolling and continue to rut and/or pump, the soil shall be scarified and moistened or aerated and recompacted. Repeat proofrolling operations.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace or scarify and air-dry satisfactory soil material that is too wet to compact to specified density.

a. Stockpile or spread and dry removed wet satisfactory soil material.

3.15 COMPACTION

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure.

C. Percentage of Maximum Dry Density Requirements: Compact soil to not less than the following percentages of maximum dry density according to ASTM D698 Standard Proctor:

1. Under structures, steps, walks, and pavements:
   a. Compact each layer of backfill or fill material at 95% of the standard Proctor Density (ASTM D-698).
   b. Compact each layer of the final 12-in of backfill material in building and pavement areas at 98% of the standard Proctor Density (ASTM D-698).
   c. Moisture content of the fill during placement shall be kept within +/-2% of optimum.
2. Under lawn or unpaved areas, compact the top 6 inches below subgrade and each layer of backfill or fill material at 90 percent maximum dry density.
3. Compact each layer of aggregate base material under pavement to 100% of the standard Proctor Density (ASTM D-698).

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between existing adjacent grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to conform to required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1.2 inches (0.10 foot).
2. Walks: Plus or minus 1.2 inches (0.10 foot).
3. Pavements: Plus or minus 1/2 inch (0.05 foot).

3.17 SUBSURFACE / FOUNDATION DRAINAGE

A. Drainage Piping: Drainage pipe is specified in Division 33 Section "Site Storm Drainage Utilities."

B. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a course of drainage fill material on drainage fabric to support drainage pipe. Encase drainage pipe in drainage fill material and wrap in drainage fabric, overlapping sides and ends at least 6 inches.

1. Compact each course of drainage fill material.
2. Place satisfactory excavated or borrow soil material or topsoil fill material (as appropriate) over drain to final grade.

3.18 BASE COURSES

A. Under pavements, walks, courts and tracks, place base course material on prepared subgrades.

1. Where indicated, place biaxial geogrid directly on prepared subgrade under all asphalt and concrete pavement without wrinkles or folds. Seems shall be overlapped a minimum of 12-in. Geogrid placement shall be observed by the Owner’s Independent Testing Agency prior to covering. Place compacted base course over geogrid and control traffic and operation of equipment over geogrid and base course in accordance with manufacturer’s instructions.
2. Compact base courses at optimum moisture content to required grades, lines, cross sections and thickness to not less than 100% of the standard Proctor Density (ASTM D-698).
3. Shape base course to required crown elevations and cross-slope grades.
4. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
5. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick when compacted.
6. Following compaction testing and within 48 hours prior to the application of asphalt or concrete pavement, the aggregate base course shall be proofrolled with a fully loaded dual wheel tandem axle dump truck or similar construction equipment. Four passes shall be made in each orthogonal direction. The proofrolling operation shall be observed by the Architect or Owner’s independent testing agency. Should any area fail to tighten up after proofrolling and continue to rut and/or pump, the base course shall be scarified and moistened or aerated and recompacted. Repeat proofroll testing.

3.19 FIELD QUALITY CONTROL

A. Owner’s Independent Testing Agency Services: Allow testing agency to evaluate and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.

1. Perform testing and evaluation of borrow or fill soils for compliance with material specifications of this Section.
2. Perform field in-place density tests according to ASTM D 1556 (sand cone method), ASTM D6938 (nuclear gauge method) or equal as determined by the Owner's independent testing agency.
3. Paved Areas (including courts and tracks): At subgrade and at each compacted fill, backfill layer, and aggregate base course layer, perform at least one field in-place density test for every 10,000 sq. ft. or less of paved area, but in no case fewer than three tests. Observe proofrolling of finished subgrade and aggregate base course.
4. Trench Backfill: Perform at least one field in-place density test per 2 feet of backfill per 100 linear feet or less of trench outside of limits of buildings, but no fewer than two tests per trench per day.
5. Non-Structural Areas: Field density and moisture content tests shall be performed on the fill and backfill at a rate of at least one test per every 15,000 square feet of area being filled.
6. Observe proof-rolling as described herein.
7. Refer to Special Inspections section below for testing within building limits.

B. When testing agency reports that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to the depth required, recompact and retest until required density is obtained. Contractor shall be responsible for all costs associated with re-testing required due to failed compaction.

C. Proofrolling: Subgrade to receive fill, finish subgrade of building or pavement areas, and aggregate base courses shall be proofrolled with a fully loaded dual wheel tandem axle dump truck or similar construction equipment. Four passes shall be made in each orthogonal direction. The proofrolling operation shall be observed by the Owner's testing agency. Should any area fail to tighten up after proofrolling and continue to rut and/or pump, the soil shall be scarified and moistened or aerated and recompacted. Repeat proofrolling operations.

3.20 SPECIAL INSPECTIONS

A. Allow Special Inspections and tests to be performed by the Special Inspector or Special Inspection Agency.

A. Verification and inspection of earthwork construction shall be in accordance with Section 1705 of the North Carolina State Building Code 2018, and as follows:

1. Review laboratory test reports, certificates of compliance, or other data submitted to show compliance with specifications, and conduct field inspections and tests during earthwork operations as necessary to verify compliance with the contract documents.
2. All site stripping and proofrolling operations shall be observed and monitored. Verify suitability of subgrade prior to installation of fill.
3. At footing subgrades, test each soil stratum to verify design bearing capacities. Verification and approval of footing subgrades may be based on a comparison of subgrade with test data. Perform additional testing as necessary.
4. Test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

    a. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of building slab, but in no case fewer than three tests.
    b. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 50 feet or less of wall length, but no fewer than two tests.

c. Trench Backfill in Building Areas: At each compacted initial and final backfill layer, at least one test for every 50 feet or less of trench length, but no fewer than two tests.

B. Allow Special Inspector to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements

C. When subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

E. Additional testing performed to determine compliance of corrected work with specified requirements shall be at Contractor’s expense.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace material to depth directed by the Architect or Owner’s independent testing agency; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where settling occurs during the Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION

SECTION 31 25 00 - EROSION & SEDIMENT CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following: Soil erosion and sedimentation control for all areas of the site that are graded or disturbed by any construction operations and elsewhere as indicated on the Drawings or specified herein. Erosion control shall be as specified herein and as may be required by actual conditions and governing authorities.

B. The Contractor is fully responsible for all applicable permits and approvals for off-site borrow and waste areas.

C. The Contractor shall have full responsibility for the construction and maintenance of erosion control and sedimentation control facilities as shown on the Drawings and as specified herein. The Contractor shall at all times provide the operation and maintenance necessary to operate the permitted sediment and erosion controls at optimum efficiency.

D. The Contractor shall provide permanent or temporary ground cover as soon as possible over disturbed areas of the site and shall provide permanent or temporary ground cover in no more than 14 days after construction activities have permanently or temporarily ceased over the disturbed area. Temporary or permanent ground cover shall be provided on slopes within 7 days after construction activities have permanently or temporarily ceased.

E. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 31 Section "Site Preparation"
2. Division 31 Section "Earth Moving"
3. Division 32 Section "Planting"

1.3 PRODUCT HANDLING

A. Deliver seed, fertilizer and other packaged materials in unopened original packages with labels legible and intact. Seed packages shall bear a guaranteed analysis by a recognized authority.

B. On-site storage of materials shall be kept to a minimum. Wet or damaged seed or other material shall be removed from the project site immediately.

1.4 MONITORING AND RECORD KEEPING

A. All sediment and erosion control devices and facilities shall be inspected at least once every seven (7) calendar days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period.

B. Stormwater discharges shall be inspected by observation for stormwater discharge characteristics (as listed below) at the above frequency to evaluate the effectiveness of the sediment control facilities, devices or practices. Observations shall be made at all stormwater discharge outfalls and other locations were concentrated stormwater discharges from the site. Observations shall be qualitative, no analytical testing or sampling is required. If any visible off-

site sedimentation is leaving the site, corrective action shall be taken to reduce the discharge of sediments.

1. Color.
2. Odor.
3. Clarity.
4. Floating solids.
5. Suspended solids.
6. Foam.
7. Oil sheen.
8. Other obvious indicators of stormwater pollution.

C. The contractor shall perform and keep records of the above inspections. Visible sedimentation found off the site shall be recorded with a brief explanation as the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. This record shall be made available to the Owner, Architect and governmental authorities.

PART 2 - PRODUCTS

2.1 SOIL AMENDMENTS AND SEED

A. Refer to Division 32 Section “Planting”.

2.2 MISCELLANEOUS

A. Gravel for Stone Filters: Washed No. 57 stone or as indicated on the drawings.

B. Silt Fence Fabric: A synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn, which is certified by the manufacturer or supplier as conforming to the following requirements.

1. Tensile Strength (Grab): 90 x 90-lbs. min., ASTM D 4632.
2. Permittivity: 0.05-sec^{-1} min., ASTM D 4491.
3. Apparent Opening Size: #30 US Sieve (0.60-mm) max., ASTM D 4751.
4. UV Resistance (500-hrs): 70%, ASTM D 4355.

C. Filter Fabric (for installation under riprap): Woven geotextile fabric, apparent opening size no larger than US Standard Sieve no. 70, min. grab strength of 120-lbs.

D. Dewatering Silt Bag: Permeable, non-woven geotextile bag manufactured to accept and filter pumped, sediment-laden water from dewatering activities. Silt bag shall be sized as appropriate for the dewatering pump discharge rate and shall be fitted with a fill spout large enough to accommodate the discharge piping of the dewatering pump. Silt bag shall be Dirtbag as manufactured by ACF Environmental, Inc. or approved equal.

E. Compost Filter Sock: Three-dimensional tubular sediment control device comprised of an organic compost filter media contained in a tubular knitted mesh sock.

1. Filter media shall be mature compost that has been certified by the US Composting Council’s Seal of Testing Assurance Program and meeting the following specifications.

a. pH: 5.0 – 8.5.
b. Moisture Content: < 60%.
c. Organic Matter: >25%, dry weight.
d. Particle Size: 99% passing 2-in sieve, 30-50% passing 3/8-in sieve.

2. Filter sock netting shall be 5-mm thick continuous HDPE filament, tubular knitted mesh with 3/8-in openings. Filled sock shall be a minimum of 12-in in diameter.
3. Stakes shall be 2x2-in x 3-ft wooden stakes.

2.3 INLET PROTECTION MEASURES

A. Manufactured Inlet Sediment Control Device: Storm drainage inlet sediment control device shall be manufactured from woven polypropylene geotextile to fit the opening of a catch basin or drop inlet to filter sediment from runoff entering the inlet. The device shall be a High Flow Siltsack as manufactured by ACF Environmental, Inc. or approved equal. Device shall be provided with an integral curb deflector if installed at a catch basin with a vertical opening adjacent to a horizontal grate.

B. Floor Drain / Area Drain Sediment Filter Device: Small size storm drainage inlet sediment control device shall be manufactured from woven polypropylene geotextile to fit into small diameter floor drains to filter sediment from runoff entering the inlet. The device shall be a Round Drain Insert as manufactured by New Pig Corp. or approved equal.

2.4 SLOPE MATTING

A. Slope Matting: Erosion Control blankets for installation on slopes (not channels) shall be a machine-produced mat of crimped wood fiber and/or other degradable fibers manufactured without nets or threads. Staples or stakes used to secure the mat shall be wood or 100% biodegradable natural material. No nets or metal staples shall be used on any areas other than within channels.

1. Excelsior Mat:

a. Fiber: Net-free, curled wood excelsior of 80% six inch or longer fiber length with a consistent width of fibers evenly distributed throughout the mat. Mat shall be smolder resistant with no chemical additives.

2. Stakes or Staples: Wood or 100% biodegradable natural material with additive to cause breakdown and 100% degradation within 24-36 months after installation.

PART 3 - EXECUTION

3.1 GENERAL

A. Existing Structures and Facilities

1. Existing structures, facilities, and water courses shall be protected from sedimentation.
2. The Contractor shall be responsible for the construction of necessary measures, and all costs shall be at the expense of the Contractor.
3. Items to be protected from sedimentation deposits shall include, but are not limited to, all downstream property, natural waterways, streams, lakes and ponds, catch basins, drainage ditches, road gutters, and natural buffer zones.
4. Control measures such as the erection of silt fences, barriers, dams, or other structures shall begin prior to any land disturbing activity. Additional measures shall be constructed as required during the construction.
5. All facilities installed shall be maintained continuously during construction until the disturbed areas are stabilized. Contractor shall remove all erosion control measures at the end of the project at his expense unless otherwise directed by the Owner or his representative.
6. Perform monitoring and record keeping as specified in this section.

3.2 PROTECTIVE MEASURES

A. Protective measures shall conform to all State and Local requirements.

B. Construction and maintenance of sediment and erosion control measures shall be in accordance with all applicable laws, codes, ordinances, rules and regulations.

1. Silt Fence: Hog wire or wire mesh fastened to posts as recommended by the Manufacturer and covered with silt fabric.
2. Berms and Diversion Ditches: These shall be graded channels with a supporting ridge on the lower side constructed across a sloping land surface. Diversion ditches and berms shall be planted in vegetative cover as soon as completed.
3. Mulching: Mulching shall be used to prevent erosion and to hold soil and seed in place during the establishment of vegetation.
4. **Matting: Temporary slope and channel matting shall be used for temporary stabilization during the establishment of seeded cover in all grassed ditches, channels, long slopes, and steep banks (6:1 or steeper) and additional areas as indicated on plans**. Matting shall be installed on any area on site as needed to provide temporary stabilization whether or not matting is indicated on the plan. Install as indicated or per manufacturer's instructions. The installation of matting may be waived by the Architect is surface stabilization is obtained by other methods within the appropriate and agreed time frames. If adequate stabilization is not obtained, the Contractor shall install matting where required at no additional cost to the Owner.
5. Build Berm, Pits and Gravel Filter as shown on Drawings. Maintain during construction to keep erosion and sedimentation to a minimum. When it is necessary to remove berm, pits, and gravel, return area to required profiles and condition.
6. Construction Entrances: Construct all entrances in accordance with plans. Maintain all ingress/egress points to prevent tracking of soil onto the Owner's, public or private roads. Any soil that is tracked onto the roads shall be removed immediately.
7. Manufactured Inlet Sediment Control Device: Install device in accordance with manufacturer's instructions and install a curb deflector if appropriate. Inspect device after each rain event and at intervals not exceeding two weeks during construction. Remove, empty, clean, and replace the device as needed during construction. Empty collected sediment in approved, protected location. Remove and dispose of device following full and permanent stabilization of the contributing drainage area.
8. Dewatering Silt Bag: Install silt bag on an undisturbed slope so incoming water flows downhill through the bag without causing erosion. Remove and replace silt bag when device no longer drains efficiently due to accumulated sediment in bag. Empty bag within disturbed limits of the site protected by other sediment control measures.
9. Compost Filter Logs: Stake filter log every 10-ft. Drive stakes through the center of the log and 1-ft into the ground. If sock netting must be joined, fit beginning of the new sock over the end of the old sock, overlapping by 1-2 ft. Fill with compost and stake the joint.
10. Other Measures: Other methods of protecting existing structures and facilities, such as vegetative filter strips, diversions, rip-rap, baffle boards, and ditch checks used for reduction of sediment movement and erosion, may be used at the option of the Contractor when approved by the appropriate State or local authorities.

C. Provide the following, at a minimum, to prevent windblown dust.

1. Apply straw mulch and establish temporary or permanent ground cover on exposed soil where work is not being actively performed.
2. Cover or establish vegetative cover on stockpiles.
3. Apply water or other approved dust suppressant as needed to soil surfaces before they become excessively dry.
4. Sweep and collect soil that has been tracked onto paved surfaces.

3.3 STABILIZATION

A. Permanently protect stabilized areas prior to the removal of protective devices.

B. After the final establishment of permanent stabilization, remove temporary sediment control measures. Re-spread accumulated sediments as specified.

C. Permanently stabilize all areas disturbed by the removal and re-spreading operations immediately.

3.4 TEMPORARY SEEDING

A. In accordance with the schedule as detailed on the drawings.

3.5 PERMANENT SEEDING

A. In accordance with the schedule as detailed on the drawings.

3.6 MULCHING AND MATTING

A. Apply mulch or matting to retain soil and grass.

B. Mulch areas with slope greater than 5% by spreading a light cover of mulch over seeded area at the rate of not less than 85 lbs. per 1000 sq. ft.

C. Install temporary matting in all grassed ditches, channels, long slopes, and steep banks (6:1 or steeper) and additional areas indicated on plans or where extra protection from erosion is needed.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs and/or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1. Perform and submit video of interior of gravity sewer pipes adjacent to the work before and after construction.

D. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.4 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
2. The geotechnical report is included elsewhere in Project Manual.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.
2. Provide special support of existing steam tunnels per the project details.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 FIELD QUALITY CONTROL

A. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

B. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.3 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."

    a. Backfill voids beneath existing steam tunnel with excavatable flowable fill.

2. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes exterior portland cement concrete paving for the following:

1. Curbs and gutters, pavement, walkways, service court, dumpster pads.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 31 Section "Earth Moving" for subgrade preparation, grading and subbase course.
2. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
3. Division 07 Section "Sealants and Caulking" for joint fillers and sealants within concrete paving and at joints with adjacent construction.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.

C. Design mixes for each class of concrete. Include percentage of recycled content (20% minimum). Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

D. Scaled plan of proposed construction, expansion and control joint locations in concrete pavement and concrete sidewalk. Submittal of plans for joints in curb and gutter or longitudinal sidewalk 6-feet or less in width is not required.

1.4 QUALITY ASSURANCE

A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.

1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete."
3. ACI 330R, “Guide for the Design and Construction of Concrete Parking Lots.”
4. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Concrete Testing Service: Engage a qualified independent testing agency to perform materials evaluation tests and to design concrete mixes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

D. Plain Steel Wire: ASTM A 82, as drawn.

E. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs. Electroplated zinc steel plates, ASTM A 108, ASTM B633 with corresponding pocket former.

F. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use one of the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, portland cement, Type I, II, or III.

a. Fly Ash: ASTM C 618, Class F. Up to 30% by weight of required cement content, with 1.0-lbs Fly Ash per 1-lb of cement replaced.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120 with 1-lb slag per 1-lb of cement replaced.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate, uniformly graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar pavement applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M, potable.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 RELATED MATERIALS

A. Expansion and Isolation Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Wheel Stops: Precast, air-entrained concrete; 2500-psi minimum compressive strength; approximately 6 inches high, 9 inches wide, and 84 inches long. Provide chamfered corners and drainage slots on underside and provide holes for dowel-anchoring to substrate.

1. Dowels: Galvanized steel, diameter of ¾ inch, minimum length 10 inches.

C. Slip Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

D. Bonding Agent: ASTM C 1059, Acrylic or styrene butadiene.

E. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi, 3500 psi, or 3000 psi as indicated on the drawings.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: As specified by NCDOT Standard Specifications for class of concrete indicated.
3. Slump Limit: Maximum 3.5 inches for non-vibrated, maximum 4 inches for vibrated.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use admixtures in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements as follows:

1. Fly Ash: 30 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash not exceeding 20 percent.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete mixes of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete mixes larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

2.9 JOINT SEALANTS

A. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

B. Round Backer Rod for Cold-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and pavement bottom-side adhesion of sealant.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving. Ensure subgrade is graded for proper drainage. Repair as needed to avoid ponding on final pavement surfaces.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

C. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase.

D. Place aggregate base courses as specified in Division 31 Section “Earth Moving”.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement. Set forms to ensure positive drainage and compliance with ADA and Building Code requirements.

B. Check completed formwork and screeds for grade and alignment to following tolerances:

1. Top of Forms: Not more than 1/8 inch in 10 feet.
2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable at mid depth of concrete. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.

1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.

B. Contraction (Control) Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as indicated below unless shown otherwise on Drawings. Construct contraction joints for a depth equal to at least 1/3 of the concrete thickness, as follows:

1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random contraction cracks.
3. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.
4. Spacing:
    a. Pavement (greater than 4-in thick slabs): Locate contraction joints at 10-ft max. intervals, each way in concrete pavement.
    b. Sidewalk & Patios (4-in thick slabs): Locate contraction joints at 5-ft max. intervals, each way in concrete sidewalks/patios unless shown otherwise. Locate contraction joints in sidewalks less than 8-ft in width at 5-ft intervals across the walk. Locate contraction joints in sidewalks of 8-ft and greater width at 5-ft intervals across the walk and equally section the walk lengthwise with joints at 5-ft. max. intervals (example: an 8-ft wide walk shall have contraction joints at 5-ft. spacing across the walk and one joint dividing the walk lengthwise into two, equal 4-ft sections.)

c. Curbs or Curb & Gutter: Locate contraction joints at 10-ft max. intervals in concrete curbs or concrete curb and gutter.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.

1. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

D. Isolation (expansion) Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. General spacing: Locate additional expansion joints at the following intervals unless indicated otherwise on the drawings.

a. Pavement (greater than 4-in thick slabs): None in addition to located specified above.
b. Sidewalks (4-in thick slabs): 30-ft each way.
c. Curbs or Curb & Gutter: 90-ft spacing.

2. Extend joint fillers full width and depth of joint 1/2 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
2. Diamond Dowel System is acceptable in lieu of round dowels. Contractor to provide submittal information to Engineer for review/approval. Install per manufacturer recommendations.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work. Ensure forms are set to ensure water will not pond on final surface.

B. Remove snow, ice, or frost from base surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.

C. Moisten base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

F. Form and pour concrete pavement with thickened edges along all edges that could be subject to vehicle wheel loads, do not abut a building or wall, or are not doweled to the adjacent pavement or structure.

G. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

H. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.

I. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.

J. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.

K. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

L. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING

A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots to ensure positive drainage and eliminate ponding. Refloat surface immediately to a uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across all site concrete sidewalk and pavement surfaces perpendicular to line of traffic to provide a uniform fine line texture finish.

B. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to a radius of ¼-inch unless indicated otherwise on the drawings. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

C. Step Tread Grooves: Tool three (3) parallel grooves along entire top front edge of new concrete stair treads.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 FIELD QUALITY CONTROL TESTING

A. The Owner shall employ an independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement in accordance with Division 01 Section “Quality Control” and as follows:

1. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.

2. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within one week of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

E. Remove and replace concrete paving or curb and gutter that ponds water.

END OF SECTION

SECTION 32 14 00 - UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Brick pavers set in aggregate setting bed.
2. Edge restraints for unit pavers.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for compacted subgrade and subbase course, if any, under unit pavers.
2. Division 32 Section "Concrete Paving" for cast-in-place concrete curbs and gutters serving as edge restraint for unit pavers.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Brick pavers.
2. Setting materials.
3. Edge restraints.

B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of unit paver indicated.

C. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

1. Include Samples of exposed edge restraints.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.

1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

B. Store liquids in tightly closed containers protected from freezing.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brick Pavers:

a. Pine Hall Brick Co., Inc.
b. Endicott Clay Products Co.
c. Glen-Gery Corporation.
d. Whitacre-Greer.

2.2 COLORS AND TEXTURES

A. Colors and Textures: Match existing on-site.

2.3 UNIT PAVERS

A. Brick Pavers: Light-traffic paving brick; ASTM C 902, Class SX, Type I, Application PX. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Re-use existing brick when available and supplement with new brick to match existing.
2. UNC Chapel Hill standard paver is “Pine Hall Brick Pathway Full Range”. Light traffic = 4”x8”x2.25” with sharp edges. The thicker Heavy-Vehicular pavers have a beveled edge but can be installed upside down with sharp edge exposed to match the Light Traffic version

2.4 ACCESSORIES

A. Job-Built Concrete Edge Restraints: Construct edge restraints using mortared paver brick as detailed on the drawings. Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Aggregate base course material.

B. Geotextile: Woven or nonwoven geotextile manufactured from polyester or polypropylene fibers, with a permeability rating 10 times greater than that of soil on which paving is founded and an apparent opening size small enough to prevent passage of fines from leveling course into graded aggregate of base course below.

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements of ASTM C 33 for fine aggregate.

D. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Vacuum clean concrete substrates to remove dirt, dust, debris, and loose particles.

B. Remove substances, from concrete substrates, that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

C. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Joint Pattern: Match existing unit paver joint pattern.

E. Tolerances: Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.

F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure

before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 AGGREGATE SETTING-BED PAVER APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 1557 laboratory density.

B. Place geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).

C. Place aggregate subbase and base in thickness indicated. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers.

D. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

E. Treat leveling base with soil sterilizer to inhibit growth of grass and weeds.

F. Set pavers with a minimum joint width of 1/16 inch (1.6 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.

1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

G. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches (900 mm) of the laying face. Cover open layers with nonstaining plastic sheets overlapped 48 inches (1200 mm) on each side of the laying face to protect it from rain.

H. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

I. Do not allow traffic on installed pavers until sand has been vibrated into joints.

J. Repeat joint-filling process 30 days later.

3.5 REPAIR, CLEANING, AND PROTECTION

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION

SECTION 32 40 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Benches.
2. Bicycle racks.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Samples: For each type of exposed finish and for each color and texture required.

C. Material Certificates: For the following:

1. Recycled plastic.

D. Maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL BENCH AND RECEPTACLE MATERIALS

A. Steel: 9 gauge expanded steel with roll-formed edges and corners.

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
3. Tubing: Cold-formed steel tubing complying with ASTM A 500.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 569/A 569M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A 569/A 569M.
6. Perforated Metal: From steel sheet not less than 0.0897-inch (2.3-mm).
7. Expanded Metal: From carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
8. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester-TGIC, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
9. PVC Finish: Manufacturer's standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

B. Anchors, Fasteners, Fittings, and Hardware: Commercial quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site and street furnishings' assembly, mounting, and secure attachment per manufacturer.

1. Material: Manufacturer's standard, corrosion-resistant-coated or non-corrodible materials.

C. Non-shrink, Nonmetallic Grout: ASTM C 1107; for exterior applications.

D. Erosion-Resistant Anchoring Cement: Factory-packaged formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended for exterior applications.

2.2 BENCHES

A. Description: Manufactured, steel frame, wood-slat bench with backs and end arms, designed to be mounted on concrete base or wall.

1. Style: Backed with end arms.
2. Length: 70-inches.
3. End Frame and Arms: 1/4” thick x 2-1/4” wide carbon steel with manufacturer’s finish.

a. Primer: Rust inhibitor.
b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip and flake resistant.
c. Color: Submit manufacturer’s full color options for selection.

4. Seat & Back Panels: 1.5” x 1.375” domestically sourced, thermally modified ash wood boards with eased edges, secured to frames with anti-corrosion-coated flat head screws. For exterior use, no finish.
5. Mounting: Bench to be anchored to concrete base/wall with stainless steel anchors provided by manufacturer.
6. Recycled Content:

a. Post-consumer recycled content: 19% min.
b. Pre-consumer recycled content: 10% min.

7. Fabrication: Shop assembled.
8. Manufacturer’s Standard Warranty: 3-year.

B. Basis of Design:

1. “Universe System” Benches by Landscape Forms, Inc. 7800 E. Michigan Ave, Kalamazoo, Michigan 49048. (800) 521-2546, www.landscapeforms.com.

2.3 BICYCLE RACKS

A. Products: (Match University Standard)

1. Maglin Site Furniture (800) 716-5506, Model MBR-0500-00001 or approved equal.
2. Madrax (800) 338-7931, Model U24-IG-P or approved equal
3. WAUSAU Tile (800) 388-8728, Model MF9015 or approved equal

B. Security: Designed to lock wheel and frame.

C. Installation Method: Per manufacturer, direct burial, install prior to paver installation.

D. Steel Finish: All surfaces shall be powder-coated.

1. Color: Black.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Complete field assembly of site and street furnishings, where required.

B. Unless otherwise indicated, install site and street furnishings after landscaping and paving have been completed.

C. Install site and street furnishings level, plumb, true, and securely positioned at locations indicated on Drawings in accordance with manufacturer's printed instructions.

END OF SECTION

SECTION 33 10 00 – SITE WATER UTILITIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The products and execution specifications and requirements of the OWASA Manual of Specifications, Standards and Design apply to this Section.

1.2 SUMMARY

A. This Section includes water systems piping for potable water service and fire protection service outside the building.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1, Section 01300 “Submittals.”

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure Ratings: Except where otherwise indicated, the following are minimum pressure requirements for water system piping.

1. Underground Piping: 200 psig.

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data, including pressure rating, rated capacity, and settings of selected models for the following:

1. Valves and boxes.
2. Pipe and Fittings.

C. Record drawings at Project closeout of installed water system piping and products according to Division 1 Section "Project Closeout."

D. Test reports specified in "Field Quality Control" Article in Part 3.

E. As-Built Survey at completion of utility installation as specified in “Quality Assurance”.

1.5 QUALITY ASSURANCE

A. All materials, construction methods and testing shall comply with the requirements of OWASA.

B. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.

C. Listing and Labeling: Provide equipment and accessories that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Product Options: Water systems specialties and accessories are based on specific types, manufacturers, and models indicated. Components by other manufacturers but having equal performance characteristics may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by Architect and OWASA. The burden of proof of equality and approval by OWASA of products is on the Contractor. Refer to Division 1 sections.

E. As-Built Survey / Record drawings at completion of installation and testing of water system piping and products according to OWASA As-Built drawing requirements. As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:

1. All fire hydrants and water valves with sizes and locations with no less than two primary reference dimensions from permanent above grade features.
2. Pipe materials and sizes.
3. Other water system components such as meters, backflow preventers, etc. with no less than two primary reference dimensions from permanent above grade features.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, for shipping as follows:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends, flange faces, and weld ends.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. Storage: Use the following precautions for valves, including fire hydrants, during storage:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect valves from weather. Store valves indoors and maintain temperature higher than ambient dew point temperature. Support valves off ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and piping specialties from moisture and dirt.

G. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Verify that water system piping may be installed in compliance with original design and referenced standards.

C. Site Information: Reports on subsurface condition investigations made during the design of the Project are available for informational purposes only; data in reports are not intended as representations or warranties of accuracy or continuity of conditions (between soil borings). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate and line stoppage with OWASA and UNC Facility Services.

B. Coordinate with pipe materials, sizes, entry locations, and pressure requirements of building fire protection and building water distribution systems piping.

C. Coordinate with other utility work.

PART 2 – PRODUCTS

2.1 GENERAL

A. All products shall comply with the OWASA Manual of Specifications, Standards and Design.

2.2 DUCTILE IRON PIPE

A. The use of standard gaskets with push-on pipe is not permitted for sizes less than 16-inches.

B. Ductile iron pipe shall be manufactured in accordance with all applicable requirements of AWWA C151/ ANSI A21.51 for 4-inch and larger diameter pipe, pressure class rated, Class 350, minimum and shall be in 18 or 20-foot lengths.

C. The ductile iron pipe shall be cement mortar lined with a seal coat in accordance with AWWA C104/ANSI 21.4. Outside coat shall be a minimum of 1-mil bituminous paint according to AWWA C151/ANSI A21.51 Section 51-8.1.

D. Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacturer to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

E. All materials used in production of the pipe are to be tested in accordance with AWWA C151 for their adequacy within the design of the pipe, and certified test results are to be provided to OWASA upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

F. Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, Atlantic States Cast Iron Pipe Company, United States Pipe and Foundry Company, or Griffin Pipe Products Company.

G. Pipe joints shall be restrained by either mechanical joint or manufactured restrained joint system, as outlined below. The use of restraining gaskets shall be permitted. This applies to all pipe sizes 4 inch through 12 inch. Acceptable types of pipe joints are as specified below.

2.3 DUCTILE IRON PIPE JOINTS

A. Push-on Joint, Ductile Iron Pipe: THE USE OF STANDARD PUSH-ON GASKETS IS NOT PERMITTED! The pipe shall conform to AWWA C151/ANSI A21.51 (such as "Fastite," "Tyton," or "Bell-Tite."). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be manufactured of an acceptable elastomeric material, and comply with AWWA C111/ANSI A21.11. and shall be as manufactured by American Pipe (Fast-Grip), Griffen Pipe (Talon RJ), US Pipe (Field Lok 350), Atlantic States (Sure Stop 350)

B. Mechanical Joint, Ductile Iron Pipe and Tee Bolts:

1. The mechanical joint shall consist of:

   a. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;
   b. A pipe or fitting spigot;
   c. Rubber EPDM material and comply with AWWA C110/ANSI A21.11 sealing gasket;
   d. Separate ductile iron follower gland having cored or drilled bolt holes; as outlined in number 3) below.
   e. Stainless steel Tee Head bolts and hexagon nuts. All threads are Coarse-Thread Series Class 2A, External and Class 2B, Internal, per ANSI B1.1. Nuts to be furnished in accordance with ASTM F594. Use of a stainless steel anti-seize compound is required or specially coated nuts to prevent galling.

2. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements of Federal Specification WW-P-421, AWWA C111/ANSI A21.11, and ASTM A536, Standard Specification of Ductile Iron Castings.

3. Tee bolts and nuts: All tee bolts shall be 304 or 316 stainless steel with either a coated heavy hex nut, or the use of stainless steel anti- seize compound, to prevent galling. Bolts shall conform to AWWA C111/ANSI A21.11. This requirement supersedes all other bolt references in the standard. Only bolts and nuts that are 304, or 316, stainless steel shall be permitted for use in the OWASA jurisdiction.

C. Mechanical Joint Restraint: Acceptable types of joint restraints shall be:

1. Restrained Joints shall consist of the use of a mechanical joint restraint system, using Megalug series 1100 mechanical joint restraint by EBAA Iron Sales, Inc., Ford wedge action restrainer gland UFR Series 1400, Sigma One-Lok, Tyler Union TUFGrip, or approved equal. Bolt heads are to be “auto-torque” twist off. Auto-torque twist off bolts are exempt from the stainless steel requirement. See OWASA Standard Detail 512.08, sheet 2 of 2 for figure of Megalug.
2. Restrained Joint Pipe shall be TR Flex or Lok Tyte as manufactured by United States Pipe and Foundry Company, Flex-Ring or Lok-Ring as manufactured by American Cast Iron Pipe Company, Snap-lok as manufactured by Griffin Pipe Products Company.
3. Concrete thrust blocking and rodding is required for connection to all existing water mains or as shown on plans.

2.4 DUCTILE IRON FITTINGS

A. Fittings shall be ductile iron, grade 70-50-05, and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings, pipe sizes 4 inches through 48 inches with the

exception of manufacturer's proprietary design dimensions and thicknesses for iron, in accordance with AWWA C110/ANSI A21.10.

B. All ductile iron fittings shall have a minimum working pressure rating of 350 psi and shall be cement mortar lined and bituminous coated (minimum 1-millimeter), in accordance with AWWA C104/ANSI A 21.4. The fittings shall be tested and the manufacturer shall provide certified test results when requested by OWASA. This testing shall include hydrostatic proof testing of fittings. Glands, gaskets, and bolts shall conform to AWWA C111/ANSI A 21.11. The use of push on fittings is not permitted.

C. Acceptable manufacturers are: American Cast Iron Pipe Company, Griffin Pipe Company, Union/Tyler Pipe Company, or U. S. Pipe & Foundry Company. Acceptable types of fittings are:

1. Full Body Mechanical Joint Fittings: Full body ductile iron mechanical joint fittings shall be class 250 minimum and shall conform to AWWA C110/ANSI A21.10. Glands, Gaskets and Bolts shall conform to AWWA C111/ANSI A21.11.
2. Mechanical Joint Fittings – Compact: Compact fittings shall be minimum class 350 and shall comply with AWWA C 153/ANSI A21.53, pipe sizes 4 inches through 48 inches. Glands, Gaskets and Bolts shall conform to AWWA C111/ANSI A21.11.
3. Mechanical Joint Restraints: Joint restraints shall consist of the use of a Megalug joint restraint system using Megalug series 1100 mechanical joint restraint by EBAA Iron Sales, Inc., Ford wedge action restrainer gland UFR Series 1400, Sigma One-Lok, Tyler Union TUFGrip, or approved equal. Bolt heads are to be "auto-torque" twist off. Auto-torque twist off bolts are exempt from the stainless steel requirement. See Standard Detail 512.08, sheet 2 of 2 for figure.

2.5 DUCTILE IRON TRANSITION COUPLINGS

A. Transition couplings shall be ANSI/NSF Standard 61 Certified, fusion bonded powder epoxy coating and constructed of ASTM A536 Standard Specification for Ductile Iron Castings, grade 65-45-12 ductile iron flanges and middle ring. Coupling to be rated at a minimum of 200 psi working pressure per AWWA C219, and -20ºF to 212º F. Gaskets shall be suitable for use on water and sewage. Bolts are to be stainless steel 18-8 Type 304. Transition couplings are to accommodate IPS PVC, C-900 PVC, Ductile Iron Pipe, Cast Iron, and Asbestos Cement Classes 100/150/200.

B. Acceptable couplings are Smith-Blair Type 441 and 461, JCM 240 for line sizes 3-inch through 12-inch and the Dresser Style 253 Modular Cast Coupling (2-inch through 16-inch), Ford Style FC2W Ultra-Flex Ductile Iron Wide Range Coupling (4-inch through 12-inch), Hymax (Standard or Long body) coupling, Romac (Macro HP) coupling with EPDM gaskets. ALL RUBBER GASKETS AND O-RINGS SHALL BE MANUFACTURED WITH AN APPROVED ELASTOMER.

2.6 COPPER PIPE

A. Copper pipe shall meet ASTM B88 Standard Specification for Seamless Copper Water Tube. 2-inch and 3-inch copper pipe shall be Type "K" hard drawn copper, brazed with Silvalloy, Excel, SilFos, or approved equal comprised of 15% silver. Brazing temperature shall be between 1,300 and 1,500 degrees Fahrenheit.

2.7 STEEL CASING PIPE

A. Steel Casing Pipe: Pipe shall be high strength steel, spiral welded or smoothwall seamless manufactured in accordance with ASTM A139 and ASTM A283 and consisting of grade "B" steel with a minimum yield strength of 35,000 psi. All encasement pipes shall meet the applicable NCDOT, Municipal, or AREMA specifications. The steel pipe shall be capable of withstanding the design load. No interior lining and exterior coating shall be required except that

all exposed metal is to be coated with epoxy or asphaltic material. Casing pipe shall include pipe carriers (Spiders) to support carrier pipe. The steel encasement pipe shall be of leak-proof construction and shall include end caps.

1. 4-in diameter encasement pipe is allowable for 2-in carrier pipe.

B. Spiders/Skids for Encasement Pipes: Spiders shall be placed at the bell of each carrier pipe within a steel encasement. Steel Spiders/Skids shall be as manufactured by ITT Grinnell, Charlotte, NC; Spider Manufacturing, Durham, NC; Advanced Products & Systems (APS) model SSI with EPDM skids, Lafayette, LA, or approved equal. Refer to OWASA Standard Detail 517.01. For bolted connections, bolts shall be 304 ASTM F593 stainless steel.

C. Steel Casing End Seals: Casing end seals shall be 1/8” thick synthetic rubber seamless pull-on end seals with T-304 stainless steel banding with 100% nonmagnetic worm gear mechanism. End seals shall permit pipe movement while maintaining a seal. Acceptable manufacturers are: Advance Products & Systems, Inc., Lafayette, LA, or equal.

2.8 VALVES

A. Gate Valves, Resilient Wedge (2 inches through 12 inches): All gate valves shall be iron body of the resilient wedge type complying with AWWA C509 and shall be UL listed and FM approved for a working pressure of 200 psi. All internal parts shall be accessible without removing the body from the line. The wedge shall be of cast iron completely encapsulated with resilient material. The resilient sealing material shall be permanently bonded to the cast iron wedge with a rubber-tearing bond to meet ASTM D429 Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates and AWWA C550.

1. Non-Rising Stems (NRS) shall be cast bronze with internal collars in compliance with AWWA. OS&Y stems shall be bronze. The NRS stuffing box shall have two "O"-Ring seals above the thrust collar. These rings shall be field replaceable without removing the valve from service.
2. Each valve shall be hydrostatically tested at 400 psi to the requirements of both AWWA and UL/FM.
3. All gate valves 4 through 12 inches shall be of the mechanical joint type. 2- inch gate valves shall be iron pipe threads.
4. All bolts and nuts shall be stainless steel.
5. Valves shall open counter-clockwise (left) and shall be equipped with a 2-inch square AWWA operating nut.
6. The valve body and bonnet shall be coated interior and exterior with fusion bonded thermosetting plastic or epoxy. ALL RUBBER GASKETS AND O- RINGS SHALL BE MANUFACTURED WITH AN APPROVED ELASTOMER.
7. Acceptable gate valves, sizes 4-inch through 12 inches, shall be: American Flow Control Series 2500SS, Clow (M&H) model F-6100, or Mueller model A-2360-20.
8. All resilient seat gate valves furnished for a project shall be from the same manufacturer.

B. Inserting Valves: Inserting valves shall meet requirements of gate valves specified above for valve mechanism and AWWA C110/ANSI A21.10 for the sleeve for pressure ratings shown on the drawings.

C. Tapping Sleeves and Valves: The tapping sleeve and valve shall be suitable for wet installation without interrupting water service.

1. Iron Body Tapping Sleeve: The sleeve body shall be of split type, full body ductile iron construction with mechanical joint ends and epoxy coating (10 mil minimum). The sleeve shall be suitable to fit the type and class of pipe being tapped. The mechanical joint type shall have longitudinal compound rubber gaskets that fit against the rubber end gaskets

effecting a totally enclosed rubber, watertight seal. Side and end bolts shall be stainless steel. Tapping sleeve shall meet the requirements of AWWA C110/ANSI 21.10. For asbestos cement pipe, the Contractor shall measure the diameter of the pipe prior to selecting a tapping sleeve to ensure the sleeve will fit the pipe (this information shall be provided to OWASA on the as-built drawings). See Standard Detail 512.04. Tapping sleeves shall be as manufactured by Tyler/Union for ductile iron pipe.

2. Tapping Valves: Resilient seat tapping valves shall be epoxy coated (minimum 10 mil thickness) and otherwise meet the requirements of Section 2.2.1, Gate Valves, except that the seat openings shall be larger than nominal size with a raised alignment ring on the flange. Valve ends shall be mechanical joint by flange. Valves shall open counter-clockwise (left) and shall have a 2-inch operator nut. See Standard Detail 512.04. Tapping valves shall be American 2500TM, Clow F-6114 or Mueller T-2360.

   a. All bolts and nuts are to be stainless steel.
   b. Tapping valves shall be an "O" ring type mechanical joint end conforming to AWWA non-rising stem construction. Inlet flange end shall be Class 125 (ANSI B16.1). ALL RUBBER GASKETS AND O-RINGS SHALL BE MANUFACTURED WITH AN APPROVED ELASTOMER. Acceptable resilient seat tapping valves are listed below:

D. Valve Boxes: Adjustable valve boxes shall be US made gray cast iron of the dimensions shown in OWASA Standard Detail 513.01 *(2-Piece Adjustable Screw Valve Box and Cover* Detail*)* of these specifications. Lids shall be heavy-duty traffic weight with the word “WATER” cast into the lid. Provide cast-iron telescoping top section of length required for depth of burial of valve and bottom section with base of size to fit over valve. Acceptable valve boxes are: Charlotte Pipe and Foundry Company Figure UTL 273 or Tyler Pipe Company 6850 Series or approved equal.

2.9 2-INCH WATER SERVICE

A. The service line for a 2-inch meter shall consist of a 2-inch tap, 2-inch type K hard drawn copper service line, a 2-inch Clow F6103, AFC series 2500SS, or Mueller H-2360-8 threaded Iron Body Gate Valve and a 2-inch x 4-inch long threaded (iron pipe thread) brass nipple.

B. Service saddles: Service saddles shall be 2-inch all bronze saddle with double bronze straps and with a grade 60 neoprene "O" ring gasket attached to the body. All rubber gaskets and o-rings shall be manufactured with an approved elastomer. The saddle casting, straps, and nuts shall be water works bronze 85-5-5-5. The saddle shall have 2-inch iron pipe threads. Acceptable service saddles are:

1. Ford 202B Series
2. Mueller BR2B

C. 2-inch meter setter/yoke: ALL BRASS PRODUCTS SHALL BE LEAD FREE AND COMFORM TO NSF61-ANNEX G IN CONJUNCTION WITH NSF372 REQUIREMENTS. ALL RUBBER GASKETS AND O-RINGS SHALL BE MANUFACTURED WITH AN APPROVED ELASTOMER. Meter Setters shall be constructed from 85-5-5-5 Brass (AWWA C800) and copper tubing, and factory tested for water-tightness before shipping. 2-inch meter setter/yoke shall be comprised of all brass and copper padlock wing inlet ball valve (lockable cut-off), angled double check outlet ball valve, 1 ¼-inch by-pass line with a 1 ¼-inch stop ball valve, in-line double check valve, and brace pipe eyelets for 1-inch pipe. Outlet connections are to be threaded. Acceptable meter setters/yokes are:

1. Ford VBHH77-18BHC-11-77 (standard 18-inch rise) Ford Drawing No. B-95270-02.
2. Mueller Drawing No. B2423-2 (must specify 2-inch meter with 15-inch rise).

D. Meter Setter Idlers: ALL BRASS PRODUCTS SHALL BE LEAD FREE AND COMFORM TO NSF61-ANNEX G IN CONJUNCTION WITH NSF372 REQUIREMENTS. Meter idlers shall be provided for the 2-inch setter. The idler is used to maintain proper spacing until a system is ready for a meter to be set. The meter idler for a 2-inch setter is manufactured by Ford and is designated as No. 7 Idler.

E. Small Meter Vaults: Small meter vaults shall be constructed of precast concrete See section 02510-2.3.E. The size and shape shall be as shown on Standard Detail 515.04. The cover shall have a minimum opening dimension of 30 inches x 36 inches.

1. Access hatches shall be constructed with an aluminum tread plate cover, extruded aluminum frame with concealed hinges, hatch drain, and stainless steel hardware. The hatch shall have a slam lock and shall have an H-20 load rating. Vaults located within vehicular travel lanes shall meet the minimum AASHTO guideline H-20 traffic loads for full H20 loads. Acceptable hatches are:

a. Bilco J-3AL-H20.
b. Halliday Products: H1R3036
c. US Foundry: THS 30x36 W/OP.

2.10 FIRE DEPARTMENT CONNECTIONS

A. Exposed, Sidewalk Fire Department Connections: 5-in x 4-in with 30-deg turndown, 5-in Storz connection inlet, 4-in female NPS outlet, lead-free. Include cap and chain; fixed (no swivel) connection. Connect to galvanized steel elbow and FDC pipe; and round sidewalk escutcheon plate marked “AUTO SPRKLR”. Provide 1-in, ¼ (quarter) turn valve tapped into FDC pipe at 12-in above finish grade.

B. Wafer Check Valve: UL Listed/FM Approved, lead free, ductile iron body, bronze clapper and seat ring, ‘O’ ring seals, stainless spring closure, with ½” ball drip valve below seat to allow valve to drain water from FDC.

C. Signage: Approx. 18”x10”, steel, white background with min. 6” red lettering, marked FDC, mounted on a galvanized steel pole with concrete footing. Mounting height to bottom of sign: 5-ft. min.

2.11 BACKFLOW PREVENTERS

A. General: As listed as approved by OWASA.

B. Reduced Pressure (RP or RPZ) Backflow Preventers – ¾” thru 2”: ASSE 1013, AWWA C511, CSA B64 Certified and USC Foundation for Cross Connection Control and Hydraulic Research approved, lead-free, with full port, resilient seated ball valve shut-off valves and ball valve test cocks. Include 2 spring loaded, center stem guided check valves and one hydraulically dependent differential relief valve.

C. Reduced Pressure Detector Assembly (RPDA) Backflow Preventers – 2-1/2” thru 10”: ASSE 1047, USC Foundation for Cross Connection Control and Hydraulic Research approved, FM approved and UL listed, lead-free, with OS&Y gate valves on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air gap fitting located between 2 positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and reduced pressure backflow preventer, for continuous-pressure application. Gate valves on backflow preventers on fire protection systems shall be equipped with supervisory switches.

2.12 PROTECTIVE ENCLOSURES

A. General: Manufactured, ASSE 1060 certified, weather-resistant enclosure designed to protect aboveground water piping equipment or specialties. Enclosures shall be sized as required for access and service of protected unit. Enclosures shall be as manufactured by Hot Box or approved equal.

1. Housing: Reinforced-aluminum or reinforced-fiberglass construction with factory applied paint. Paint color to be selected by Designer from manufacturer's standard color choices. Unpainted aluminum exterior will not be allowed.
2. Drain opening: Sized to alleviate a full release by the backflow preventer.
3. Access doors with locking device.
4. Insulation inside housing.
5. Thermostatically controlled electric heater (for 2-1/2" or larger backflow preventers) or plug-connected self-limiting temperature control pipe heating cable (for 2" and smaller backflow preventers) and connection to power supply. Heating equipment shall be designed and furnished by the enclosure manufacturer and shall be listed for damp/wet locations.
6. Concrete base slab: 4 inch thick of dimensions required to extend at least 6 inches beyond edges of housing. Provide PVC sleeves at pipe penetrations of slab.
7. Anchoring devices to attach housing to base with stainless steel mounting hardware.
8. Coordination: Coordinate with other trades for installation of electrical services, GFI, tamper switches, temperature sensors, and connections to fire alarm systems as applicable. Locate GFI and other electrical components away from water discharge from backflow devices.

2.13 ALARM DEVICES

A. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

2.14 ANCHORAGES

A. Clamps, Straps, and Washers: ASTM A 506, steel.

B. Rods: ASTM A 575, steel.

C. Rod Couplings: ASTM A 197, malleable iron.

D. Bolts: ASTM A 307, steel.

E. Cast-Iron Washers: ASTM A 126, gray iron.

F. Concrete Reaction Backing: Portland cement concrete mix, 3000 psi.

1. Cement: ASTM C 150, Type I.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

2.15 IDENTIFICATION

A. Metallic Underground Warning Tape: Metallic detectable underground warning tape shall consist of a solid aluminum foil core, 35 gauge minimum, encased on each side with plastic (minimum overall thickness 5 mils) and be 3 inches wide with black lettering imprinted on a color coded background that conforms to APWA uniform color code specification (BLUE) and silver with black ink letters. Minimum tensile strength shall be 22 lbs/inch. Soil tolerance range to be

pH 2.5 to pH 11.0. On one side of the tape, the text shall include the wording “WATER LINE BELOW” repeated along the length of the tape. Underground warning tape is to be placed 18 to 24 inches below the finished grade directly above the line.

B. Tracer Wire: Tracer wire shall be as manufactured by Copperhead Industries, LLC. The wire shall be 12 AWG superflex expanded or approved equal. The wire color shall be appropriate for the utility being installed. Blue for potable water.

PART 3 – E X E C U T I O N

3.1 GENERAL

A. All construction shall conform to the OWASA Manual of Specifications, Standards and Design, the NC Plumbing Code, the NC Fire Code, OSHA, NFPA, and UNC Standards as applicable in addition to the requirements state herein.

3.2 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.3 JOINT CONSTRUCTION

A. Ductile-Iron Piping Gasketed Joints: Construct joints according to AWWA C600.

B. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated except where deviations to layout are approved on coordination drawings.

B. Install components having pressure rating equal to or greater than system operating pressure.

C. Install piping free of sags and bends.

D. Install fittings for changes in direction and branch connections.

E. Piping Connections: Except as otherwise indicated, make piping connections as specified below within vaults or above-ground. Do not use flanges, unions or keyed couplings at underground installations.

1. Above grade: Install flanges, in piping 2-1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
2. Below grade: Join ductile iron pipe with push-on joints. Join fittings with mechanical joints.

F. Cutting Pavement: Where the water line is in an existing paved area, the edges of the pavement for the water line shall be cut in a straight line, parallel to the pipe on each side. Perform cutting operations prior to installation of water line to avoid excessive removal of asphalt. Care shall also be taken during installation of pipe to avoid damage to adjoining paved surfaces.

G. Protection of Pavement: Whenever the water line is to be placed in or near a paved street, the Contractor shall provide pads or take necessary precautions to protect the pavement from

damage by construction equipment. Pavement damage by cleats or tracked equipment, or by any other means, shall be repaired by the Contractor.

3.5 PIPING INSTALLATION

A. Water Main Connection: Connect new water line to existing fire hydrant leg. Coordinate any water shut-downs with OWASA, the Town of Chapel Hill and UNC.

B. Comply with requirements of NFPA 24 for materials and installation.

C. Install ductile-iron pipe and ductile-iron and cast-iron fittings according to AWWA C600.

D. Bury piping at minimum cover of not less than 42 inches below finished grade.

E. Install and test fire protection piping and appurtenances in accordance with the specific requirements of OWASA and applicable NFPA requirements.

3.6 ANCHORAGE INSTALLATION

A. Anchorages: Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron Piping: According to AWWA C600.
2. Fire Service Piping: According to NFPA 24.

B. Apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of installed ferrous anchorage devices.

3.7 LARGE WATER TAPS

A. Tapping sleeves and valves shall be installed in accordance with the manufacturer's recommendations at locations shown on the plans. With prior approval, when taps are made on asbestos cement pipe, the Contractor shall excavate at the location of the tap and measure the diameter of the pipe prior to selecting a tapping sleeve to ensure the sleeve will fit the pipe (this information shall be provided to OWASA on the as-built drawings).

B. Taps shall be performed by OWASA. Fees must be paid by the Contractor 48 hours in advance of tapping the main. Contactor is responsible for traffic control, excavating, dewatering, and safe access in the trench at the time of tap.

C. The contractor is to provide taping sleeve and valve. Contractor must have approved traffic control plan. Work shall be scheduled at least one week in advance through OWASA’s inspector. A crewman from the OWASA Distribution and Collections Division shall be present during the operation.

D. After installation of the tapping sleeve and valve and prior to performing the tap, the assembly shall be air tested at 100 psi. Such pressure shall be maintained with no loss for a minimum time of 5 minutes.

3.8 2-INCH SERVICES

A. General: Taps into existing (in-service) water mains shall be made by OWASA personnel only. Contractor shall furnish all materials. All fees must be paid by the Contractor and work scheduled with OWASA Operations Department before OWASA will make the tap. All materials must be on-site, trenches open, and shoring and traffic control devices in-place before OWASA

will perform the tap. Contractor may be required to provide approved traffic control plan if required by inspector.

B. 2-inch taps shall be made using a 2-inch all bronze double strap tapping saddle, a 2-inch diameter x 4-inch long brass threaded nipple, and a 2inch threaded Iron body gate valve.

C. OWASA shall make the tap. Contractor shall dig hole at main, run line, and furnish all materials.

D. Meter boxes for 2-inch meters shall be placed on a 6-inch bed of clean #57 stone. Meter boxes shall be set so that there is a minimum 12 inches of clearance between the top of the box and the cut-off nut on the meter setter. The meter setter shall be straight, level, and centered in the box. Meter boxes shall be set to avoid inflow of surface water. Drains for 2 inch meter vaults shall be installed if grade allows.

E. Meter setters for 2-inch meters shall be provided with a section of copper pipe extending horizontally 24 inches out the back of the meter box. The outlet connection on 2-inch meter setters shall be plugged with a pipe plug until pressure testing has been completed on the section of main to which it is connected. Setters are to be perpendicular to meter and vertical. For 2-inch setter, use a 17-inch long idler bar with two 1/8 rubber gaskets. The idler is used to maintain proper spacing until a system is ready for a meter to be set. The setter should have an opening of 17 ¼ inch.

3.9 BORE AND JACK INSTALLATION

A. Investigate subsurface conditions (hand auger) and utility locations prior to installation.

B. The encasement pipe shall be beveled and prepared for field welding at the circumferential joints. Joining of steel casing pipe shall meet the requirements of AWWA C206.

C. Encasement ends shall be enclosed as shown on OWASA Standard Detail 517.01. All exposed metal is to be coated with epoxy, asphaltic material or be stainless steel.

D. Limit bore launch pit to the limits shown on the plans to minimize tree impacts and avoid walkway closures. Install adequate barricades.

3.10 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to plumbing and health department authorities having jurisdiction.

B. Do not install bypass around backflow preventer.

C. Do not install reduced-pressure-principle-type in pit.

D. Support backflow preventers, valves, and piping on 3000-psi minimum, portland-cement-mix concrete piers.

E. Contractor shall contract with qualified personnel to perform and provide certification of installed backflow prevention devices.

3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install fire department connections in locations indicated in accordance with NFPA 14 and 24.

B. Install wafer check valve with ball drip valve at each fire department connection. Install concrete or cast iron vault set on #57 washed stone at wafer check valve.

C. Orient nozzle of FDC toward vehicle travel way.

D. Install signage out of pedestrian and vehicle travel ways near FDC. Front of sign to face primary vehicle travel way.

3.12 ALARM DEVICE INSTALLATION

A. Comply with NFPA 24 for devices and methods of valve supervision.

B. Supervisory Switches: Supervise valves in open position.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 22.

3.13 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tape during back-filling of trench for underground water service piping. Locate 6 inches to 8 inches below finished grade, directly over piping.

B. Install copper tracer wire along all water lines.

3.14 REMOVAL OF ASBESTOS CEMENT PIPE

A. The Contractor is hereby advised that some of the pipe within the OWASA distribution system may contain asbestos. Removal, handling, and disposal of asbestos cement pipe shall be performed in accordance with applicable EPA and OSHA regulations and applicable Federal, State and local regulations. Documentation and paperwork as well as a chain of custody are to be provided to OWASA.

3.15 ABANDONMENT OF EXISTING WATER SERVICES

A. When abandoning services 2-inch in diameter, the valve shall be closed and the pipe cut and removed from the valve, a threaded plug shall be installed into the valve body. On lines smaller than 2” in diameter, the corporation stop shall be turned to the off position, a flair cap placed on the corporation stop and the line shall be cut as close to the main as possible and a one-foot segment of the line removed.

3.16 TESTING

A. NFPA Private Fire Service System Flushing & Testing: Perform flushing and all tests as required by NFPA 14 and NFPA 24. Contractor is responsible for performing and coordinating fire system installation and testing in accordance with the requirements of OWASA.

1. Prior to covering the joints of underground pipe, the pipe shall be hydrostatically tested for 2 hours at a pressure of 200 psig. Leakage allowance shall be within the limit specified in NFPA 24. The municipal water main and the plumbing system shall be isolated for this test.
2. Complete and submit “Contractor’s Material and Test Certificate for Underground Piping” (NFPA 13, 14 and 24) upon satisfactory completion of system flushing and all tests.

B. OWASA Testing: Pipelines shall be tested, in sections between valves, as soon as the installation is completed. Using this method, errors in workmanship can be identified immediately and leaks can be fixed quickly and with minimum expense. Prerequisite conditions for Testing and Disinfection shall be as follows:

1. Pipelines and appurtenances have been laid and the trench backfilled.
2. Valves shall be properly located, operable, and at correct elevation. Valve boxes or manholes shall be centered over operating nuts and the top of the box or manhole shall be at proper elevation.
3. All services shall be installed complete with setters (Contractor shall provide a meter, approved by OWASA, for pressure testing). There shall be no bypass around the meter used for pressure testing.
4. All reaction anchors (if necessary) have had sufficient set of 7 days or high early strength concrete may be used to reduce the curing time to 3 days. For high early concrete mix, use 4,500 psi or greater concrete. Temporary bracing shall not be allowed.
5. Lines shall be properly vented where entrapped air is a consideration.
6. All visible leaks, broken or cracked pipe, valves, etc. shall be repaired.
7. Air release valves shall be installed complete and in place after pressure test.
8. All construction activities on the project, that requires trenching or excavation within the limits of the water location shall be completed. Pavement base course and curb and gutter shall be in place before sampling. Pressure testing is to be performed before pavement is put down.
9. Line shall be disinfected and samples collected.
10. Approval from OWASA's Inspector on section of line to be tested.
11. The Contractor shall provide all materials, equipment, taps, and accessories required for filling, testing, and flushing.

B. Fill Line: Fill the system slowly with water, at a velocity of approximately 1 foot per second, while necessary measures are taken to eliminate all air at the highest points of the system where air may collect in pockets. After filling, shut off system in order to prevent contaminated water from flowing back in the line supplying the water

C. Flushing: Allow filled system to set undisturbed for a minimum of 24 hours, then begin flushing operations. Flushing shall be a velocity of not less than 2.5 feet per second to remove sediment and other foreign matter until the water runs clear. For lines larger than 12 inches, follow AWWA guidelines. The Contractor shall be responsible for making adequate provisions for drainage of large volume of flushing water, including proper de-chlorination/disposal of chlorinated water. All water shall be chemically de-chlorinated. Any damages that may occur from this operation shall be the sole responsibility of the Contractor.

1. Contractor shall be responsible for ensuring all waterlines are fully flushed and free of all deleterious matter prior to connecting to the building plumbing system.

D. Pressure Test:

1. The Contractor shall hydrostatically test completed sections of water line and fittings with water. OWASA reserves the right to test all lines connected to the OWASA system. This testing, however, does not relieve the Contractor of his responsibility to repair or replace all workmanship and defective pipe. All work necessary to secure a tight line shall be done at the Contractor's expense. Testing shall be performed in the presence of OWASA's Representative.
2. All additions or replacements to water system, including water services, and backflow prevention devices, shall be tested. Such work must take place under the supervision of OWASA's Representative.
3. The newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for two hours to a leakage test with a beginning test pressure of 150% of

design working pressure, but no less than 200 psi. The test pressure shall be slowly brought to the designated pressure by use of a hand pump or power pump. Only OWASA personnel shall operate water valves on OWASA's existing water system. Extreme care shall be used to prevent backflow into the potable water supply. The lines should be allowed to stand under pressure for a period of 24 hours prior to the test. Air should be vented from all high points just prior to the test. Only clean water, free of dirt and other debris, from a clean container shall be used for testing. The Contractor shall notify OWASA's Inspector a minimum of 48 hours in advance of any expected test. The Contractor shall pretest all mains for a period of 2 hours before notifying OWASA for a final pressure test. No final pressure test will begin after 2:00 PM. The maximum allowable leakage shall be no greater than allowances shown in Section 5.2, Table 5A - Hydrostatic Testing of AWWA C 600-05, *AWWA Standard for Installation of Ductile Iron Water Mains and Their Appurtenances*. No leakage shall be allowed for services.

4. OWASA's Representative will verify 1 pressure test – the final observation of the test section. A fee will be charged if the OWASA Representative is required to make more than 1 trip to verify a pressure test on the same section of main being tested.

E. Chlorination of line: Chlorination of the line shall be performed by one of the methods described in OWASA Standard Specification Section 02510, 3.4.D.1. An OWASA representative will perform a high range chlorine concentration test. Chlorine concentration of 100 mg/l minimum must be provided. Allow chlorinated water to set in the test section for 48 hours. The chlorine concentration shall not drop below 20 ppm within a minimum period of 48 hours. See OWASA Specification Section 02510, 3.4.D, Disinfection and Bacteriological Testing for additional information.

F. Sampling – Day 1: Check chlorine and turbidity. Once the control valve has been opened a continuous flow of water shall be maintained until all samples have been collected. After allowing the system to flush so that at least two volumes of water pass through the main, the first bacteria sample shall be collected at regular intervals not exceeding 1,200 feet, and tested for bacteriological quality. The contractor shall be responsible for making adequate provisions for drainage of large volume of flushing water, including proper de-chlorination/disposal of heavily chlorinated water. See Section 3.4.D, Disinfection and Bacteriological Testing.

1. Services shall be included in the main line disinfection process. The Contractor shall have the same responsibility for laterals as for the mains in regard to bearing full cost of any corrective measures needed to comply with either the bacteriological test or other such requirements.

G. Sampling – Day 2: The water main shall not be flushed for more than 5 minutes before the first sample is collected. OWASA's Representative will check both chlorine concentration and turbidity. If within the acceptable limits, a second bacteriological test will be performed collecting from the same discharge points as on day one. If the second bacteria sample has passed, the system may be left in service if NCDEQ PWS section final approval has been granted.

H. Final: After Final Approval by NCDEQ PWS section is granted, confirm all valves are fully open and flow all fire hydrants.

I. Backflow Prevention Device Certification

1. All new backflow prevention devices shall be tested and certified by an inspector approved by the City of Raleigh prior to operation of the water system. Performance, coordination and submittal of documentation of the testing and certification shall be the responsibility of the Contractor.

3.17 FINAL ACCEPTANCE

A. Upon completion of water main installations and prior to acceptance, the Contractor shall provide adequate and competent personnel to conduct, in conjunction with the OWASA Representative, an inspection of each valve and hydrant on the newly completed main. The purpose of this inspection shall be to insure the operability and location of each valve and to further insure that all valves are left in the open position.

B. Fire hydrants shall be greased and painted.

C. Flow tests are to be performed on each hydrant to verify both that flows

END OF SECTION

SECTION 33 30 00 – SITE SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sewerage systems outside the building.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 1, Section “Submittals.”
2. Division 3 Section "Cast-in-Place Concrete" for cast-in-place concrete structures.

1.3 DEFINITIONS

A. Sewerage Piping: System of sewer pipe, fittings, and appurtenances for gravity and pressure flow of sanitary sewage.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for the following:

1. Cleanouts.
2. Pipe and fittings.
3. Couplings.
4. Manhole Appurtenances.

C. Shop drawings for precast concrete manholes and other structures. Include frames, covers, and grates.

D. Shop drawings for cast-in-place concrete or field-erected masonry manholes and other structures. Include frames, covers, and grates.

E. Record drawings at Project closeout of installed sanitary sewer system piping and products according to Division 1 Section "Project Closeout."

F. Inspection and test reports specified in the "Field Quality Control" Article.

G. As-Built Survey at completion of utility installation as specified in “Quality Assurance”.

1.6 QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage systems.

B. All materials, construction methods and testing shall comply with the requirements of the OWASA Public Utilities.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Product Substitutions."

D. As-Built Survey / Record drawings at completion of installation and testing of sanitary sewer system piping and products according to OWASA As-Built drawing requirements. As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:

1. Manhole inverts and top elevations and locations with no less than two primary reference dimensions from permanent above grade features.
2. Pipe materials, sizes, lengths and slopes.
3. Other system components such as cleanouts with no less than two primary reference dimensions from permanent above grade features.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures in direct sunlight.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, pipe fittings, and seals from dirt and damage.

D. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.8 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate sanitary sewerage system connections to municipality’s sanitary sewer.

B. Coordinate with interior building drainage systems.

C. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Ductile-Iron Gravity Sewer Pipe and Fittings: AWWA C150 and C151, Pressure Class 350 minimum, for push-on joints per AWWA C111. Pipe shall be designed for an 8-foot minimum cover and a Type 1 laying condition.

1. Standard-Pattern, Ductile-Iron and Cast-Iron Fittings: AWWA C110, for push-on joints.
2. Compact-Pattern, Ductile-Iron Fittings: AWWA C153, for push-on joints.
3. Pipe and Fitting Exterior Coating: AWWA C151, asphaltic-material seal coat, minimum 1-mil thickness.
4. Pipe and Fitting Interior Lining: Calcium aluminate mortar or other acceptable epoxy liner as required and approved by OWASA.
4. Gaskets: AWWA C111, rubber.

B. Polyvinyl Chloride (PVC) Pressure Sewer Forcemain Pipe and Fittings: ASTM D2241, SDR-21, Class 200 pressure pipe with bell end with gasket and spigot end.

1. Force main piping shall be continuously marked “SEWER” or continuously wrapped with green “SEWER” locator tape.

2.2 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined, for nonpressure joints.

1. Sleeves for Cast-Iron Soil Pipe: ASTM C 564, rubber.
3. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.
4. Sleeves for Dissimilar Pipes: Compatible with pipe materials being joined.
5. Bands: Stainless steel, at least one at each pipe insert.

2.3 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.

1. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent floatation.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated. Manholes greater than 10-ft in depth shall be 60-inch diameter.
4. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
5. Joints: Plastic cement putty meeting Fed Spec SS-C-153, ‘O’-ring meeting ASTM C443, or “ram neck”.
6. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match a 24-inch-diameter frame and cover.
7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Manhole Frames and Covers: ASTM A48, Class 35, cast iron. Include 22-1/4-inch inside diameter by 7-1/2-inch riser with 4-inch minimum width flange, and 23-1/2-inch- diameter cover. Include indented top design with “OWASA – DANGER – ENTRY PERMIT REQUIRED-SANITARY SEWER” cast into cover:

2.4 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Structures: Portland-cement design mix, 4000 psi minimum, with 0.45 maximum water-cement ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland-cement design mix, 4000 psi minimum, with 0.45 maximum water-cement ratio.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground structures.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.3 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sewerage piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where fittings are indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

F. Extend sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

G. Install gravity sewer piping pitched down in direction of flow, at minimum slope and cover as indicated.

H. Install pressure forcemain piping pitched up in direction of flow, at minimum cover as indicated.

H. Tunneling: Install pipe under streets or other obstructions, that cannot be disturbed, by tunneling, jacking, or a combination of both.

3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following.

B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: With rubber compression gaskets according to CISPI "Cast Iron Soil Pipe and Fittings Handbook," Volume I. Use gaskets that match class of pipe and fittings.

C. Ductile-Iron Pipe with Ductile-Iron or Cast-Iron Fittings: With push-on-joint, rubber gaskets according to AWWA C600.

D. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:

1. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
2. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.
3. Join profile sewer pipe and ribbed drain pipe and gasketed fittings with elastomeric seals according to ASTM D 2321 and manufacturer's written instruction.
4. Install according to ASTM D 2321.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with accessories, as indicated.

B. Form continuous concrete channels and benches between inlets and outlet, where indicated.

C. Set tops of frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches above finished surface elsewhere, except where otherwise indicated.

D. All manholes in roadways shall be encased in a 3,000-psi concrete collar beneath the asphalt.

E. Place precast concrete manhole sections as indicated, and install according to ASTM C 891.

1. Provide joint gasket at joints of sections.
2. Apply bituminous mastic coating at joints of sections.

3.6 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.7 ABANDONMENT OF EXISTING SEWER LINES AND MANHOLES

A. Sewer lines: Sewer pipes shall be abandoned by filling with grout / flowable fill concrete (50 psi minimum/ 150 psi maximum).

1. Seal downstream manhole penetration with non-shrink grout of hydraulic cement.

3.8 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and whenever work stops.
3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visual between structures.
b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects. Refer to OWASA’s Manual of Specifications, Standards and Design for additional information and requirements.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to OWASA.
3. Schedule tests, and their inspections by OWASA, with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. Perform tests as required by OWASA.

a. Allowable Leakage: Maximum of 100 gallons per inch nominal pipe size per mile of pipe per 24-hours.
b. Gravity Sewers: Perform Low-Pressure Air test according to ASTM F1417 and OWASA Standards.
c. Pressure Force Main: Perform hydrostatic pressure test according to AWWA C600 and OWASA Standards.
c. Manholes: Perform vacuum test according to ASTM C1244 and OWASA Standards.

7. Leaks and loss in test pressure constitute defects that must be repaired.
8. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 33 40 00 - SITE STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes site drainage systems outside the building. Systems include the following:

1. Storm drainage.
2. Foundation drainage connections outside of building.
3. Roof drainage connections outside of building.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 31 Section “Earth Moving.”
2. Division 31 Section “Sediment and Erosion Controls.”
3. Division 3 Section “Cast-In-Place Concrete.”
4. Division 15 Sections for storm drainage inside the building.

1.3 DEFINITIONS

A. Drainage Piping: System of pipe, fittings, and appurtenances for gravity flow of storm drainage.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. As-Built Survey / Record drawings of installed drainage system piping and basins and all stormwater management devices (ponds, wetlands, bio-retention areas). Survey shall be submitted as soon as possible and at least 30-days prior to the project’s substantial completion and prior to plant installation in wetlands and other similar devices.

1.5 QUALITY ASSURANCE

A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage systems.

B. Utility Compliance: Comply with regulations pertaining to storm drainage systems.

C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Products."

D. Perform As-Built Survey of installed drainage system piping and basins and all stormwater management devices (ponds, wetlands, bio-retention areas). As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:

1. All inlet, junction box and manhole locations with no less than two primary reference dimensions from permanent above grade features.
2. As-built rims and inverts noted.
3. Pipe materials and sizes, plus slopes and distances between structures.
4. As-built dimensions for installed riprap dissipater pads.
5. Topography of embankments and interiors of drained stormwater management ponds, wetlands and bio-retention cells. Topography shall include all survey point elevations.
6. Detailed as-built dimensions and elevations of stormwater management device outlet structures, weirs, orifices, and outlet pipes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures in direct sunlight.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, pipe fittings, and seals from dirt and damage.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate storm drainage system connections to utility company's storm sewer.

B. Coordinate storm drainage system connections to existing on-site storm sewer.

C. Coordinate with interior building drainage systems.

D. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. General: Refer to plans for specific pipe material applications.

B. Ductile-Iron Pipe: ANSI/AWWA C150/A21.50 and C151/A21.51, minimum pressure class 250.

1. Lining: AWWA C104, cement mortar, coal tar expoxy lined.
2. Gaskets, Glands, and Bolts and Nuts: AWWA C111.
3. Push-On-Joint-Type Pipe: AWWA C111, rubber gaskets.
4. Coating: AWWA C151, bituminous coating.

C. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D-1785, SCH 40 PVC for solvent-cemented or gasketed joints.

1. Primer: ASTM F 656.
2. Solvent Cement: ASTM D 2564.
3. Gaskets: ASTM F 477, elastomeric seal.

D. Reinforced-Concrete Sewer Pipe and Flared End Sections: ASTM C 76, Class III. Provide Class IV where noted on the drawings.

1. Standard Joints: Plastic cement putty seal meeting ASTM C990 and Federal Specification SS-S-00210.

E. High Density Polyethylene (HDPE) Pipe and Fittings: AASHTO M252, M294, MP6, or MP7. Dual-wall with smooth interior and corrugated exterior. All sizes shall conform to the AASHTO classification Type S or D. N-12 or N-12HC by ADS or approved equal.

1. Watertight Joints: Watertight per ASTM D3212, AASHTO M294, MP6 or MP7, bell and spigot, rubber gasket, ASTM F477.
2. Fittings: AASHTO M252, M294, MP6 or MP7, welded on the interior and exterior at all junctions. Only fittings supplied or recommended by the pipe manufacturer shall be used.

F. Polypropylene Pipe (PP) and Fittings: ASTM F2881 or AASHTO M330. Dual-wall with smooth interior and corrugated exterior. Pipe within public right of way shall comply with NCDOT Specification Section 1032-9. Pipe shall be HP Storm pipe by ADS or approved equal.

1. Watertight Joints: Watertight per ASTM D3212, AASHTO M330, bell and spigot, rubber gasket, ASTM F477.
2. Fittings: Conform to ASTM F2881 or AASHTO M330. Connections shall be watertight bell and spigot utilizing a welded or integral bell and valley or inline gaskets. Only fittings supplied or recommended by the pipe manufacturer shall be used.

2.2 FOUNDATION DRAIN PIPING

A. Foundation Drain Pipe and Fittings: SCH 40 PVC or dual-wall, smooth interior HDPE as specified above, with ½-in drilled perforations. Minimum 4-inch diameter unless otherwise indicated on the drawings. Non perforated pipe shall be used outside of area to be drained to connect sub-drains to drainage inlets.

B. Filter Fabric: Woven geotextile Drainage (Filter) Fabric as specified in Division 31 Section “Earth Moving.”

2.3 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Connection from roof downspout to underground storm pipe.

1. Vertical stainless-steel downspout adapter with sch. 40 PVC pipe outlet sized to fit over downspout and underground piping. Adapter shall have a self-cleaning debris trap consisting of a hinged cover and removable debris screen. Powder-coat color to be selected by Architect from manufacturer’s full range of colors. As manufactured by Piedmont Pipe Construction.
2. Manufactured fitting of material similar to downspout sized to connect to standard round pipe shape of underground piping.

2.4 DRAINAGE INLETS

A. Drop Inlets: Brick and mortar, of depth, shape, and dimensions indicated. Precast concrete basins may be used in lieu of brick upon approval by the Architect. Precast basins shall include grade rings to allow adjustment to rim elevations. Knock-out waffle boxes shall not be used. All structures shall be designed to withstand AASHTO H-20 loads.

1. Base, Channel, and Bench: Concrete.
2. Wall: ASTM C 32, Grade MS, clay brick masonry units.

a. Option: ASTM C 55, Grade S-II, solid concrete brick masonry units may be used instead of clay brick.

3. Mortar: ASTM C 270, Type S, using ASTM C 150, Type I, portland cement.
4. Frames and Grates: ASTM A48, Class 35B, cast iron, H-20 loading. Include flat grate with small square or short-slotted drainage openings as indicated on the drawings. Provide grate with openings compliant with ADA standards when located within or immediately adjacent to sidewalk or other pedestrian walking areas and/or where specifically indicated on drawings.

B. Window Well Drain: 12-inch diameter, domed, Dura-Coated cast iron body with 6-inch bottom outlet, seepage pan, adjustable extension frame and medium duty slotted, domed grate.

2.5 CLEANOUTS

A. Description: ASME A112.36.2M, round, cast-iron housing with clamping device and round, secured, scoriated, cast-iron cover. Include cast-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Cleanout shall be rated for “heavy duty” top-loading classifications.

1. Cleanout Box: Cleanouts located in paved areas subject to vehicular traffic shall be protected by an 8-in diameter, ductile-iron cleanout box. ‘STORM’ marking shall be cast into the lid.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type I, 3,000-psi.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Structures: Portland-cement design mix, 4000 psi minimum, with 0.45 maximum water-cement ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

3.3 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical. Refer to drawings for material and structure types for specific applications.

1. Orient grates of drainage structures in paved areas to align with general pattern of pavement joints and scoring.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

D. Extend drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

E. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent and 36-inch minimum cover, except where otherwise indicated.

F. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:

1. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
2. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.
3. Join profile sewer pipe and ribbed drain pipe and gasketed fittings with elastomeric seals according to ASTM D 2321 and manufacturer's written instruction.
4. Install according to ASTM D 2321.

G. Install PP and HDPE pipe in accordance with ASTM D2321 with the exception that minimum cover in trafficked areas shall be 12-inches.

1. Slightly scarify and grade the trench base to provide a uniform trench bottom. Before installing pipe, bring bedding material or trench bottom to grade along the entire length of the pipe. For 42” pipe and larger, shallow bell holes shall be provided.
2. Trench width shall be wide enough to accommodate compaction equipment. Refer the manufacturer’s recommendations. Pipe backfill to springline shall be compacted to 95% Standard Proctor density regardless of pipe location.
3. Provide bedding, haunching and initial backfill of Class 1 or 2 granular materials per manufacturer’s recommendation or as detailed on the drawings.
4. Excessive groundwater necessitates dewatering. Pipe will float in standing water, requiring immediate haunching and initial backfill to hold line and grade.
5. Join pipe per manufacturer’s instructions.

H. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

I. Install stormwater control measure outlet pipes through embankments with concrete support cradle from the bottom of the pipe trench to the springline of the pipe.

3.4 DROP INLET INSTALLATION

A. Construct inlets to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

B. In Paved Areas: Cleanouts shall be installed within a protective cleanout box set flush with surface of paving.

C. In Non-Paved Areas: Set cleanout tops 1 inch above surrounding earth grade.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping that is indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either of the following procedures:

1. Close open ends of piping with at least 8-inch-thick brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use either of the following procedures:

1. Remove structure and close open ends of remaining piping.
2. Backfill to grade according to Division 2 Section "Earthwork."

3.7 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and whenever work stops.
3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of the Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visual between structures.
b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.

d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. All PP and HDPE pipe and fittings 12-inch in diameter and greater shall be inspected by the pipe supplier/manufacturer following delivery to the construction site for damage caused during transit. Damaged or defective materials shall be removed from the site. A record of this inspection(s) shall be submitted to the Architect. Contractor shall supply documentation of experience in the installation of PP and HDPE storm drainage pipe or shall provide for installation supervision by the supplier/manufacturer.

D. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests, and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
4. Submit separate reports for each test.

END OF SECTION