PROJECT MANUAL

UNCW RANDALL LIBRARY RENOVATION AND EXPANSION

SCO # 18-19656-02C

WILMINGTON, NORTH CAROLINA

PACKAGE C - BID DOCUMENTS
JULY 1, 2022

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PROJECT MANUAL

FOR

UNCW RANDALL LIBRARY RENOVATION AND EXPANSION

WILMINGTON, NORTH CAROLINA

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TABLE OF CONTENTS

VOLUME ONE

BIDDING AND CONTRACT DOCUMENTS

State Form OC-15: General Conditions of the Contract - Standard Form for Construction Manager-At-Risk Projects
Supplementary General Conditions

MBE GUIDELINES AND FORMS

MBE Guidelines
Identification of Minority Business Participation
Affidavit A
Affidavit B
Affidavit C
Affidavit D
Appendix E

PROJECT INFORMATION

003100 Available Project Information
Geotechnical Engineering Report, dated August 19, 2020
Geotechnical Engineering Report Addendum, dated October 1, 2020
Geotechnical Engineering Report Addendum Letter 2, dated January 27, 2021
Geotechnical Engineering Report Addendum Letter 3, dated February 3, 2022

DIVISION 1 - GENERAL REQUIREMENTS

011000 Summary
012100 Allowances
012200 Unit Prices
012300 Alternates
012500 Substitution Procedures
Contractor's Request for Substitution Form
012900 Payment Procedures
013100 Project Management and Coordination
013200 Construction Progress Documentation
013233 Photographic Documentation
013300 Submittal Procedures
Digital Data Letter of Agreement
014000 Quality Requirements
014200 References
014339 Mockups
015000 Temporary Facilities and Controls
016000 Product Requirements
017300 Execution
017419 Construction Waste Management and Disposal
017700 Closeout Procedures
017823 Operation and Maintenance Data
UNCW Active Asset Groups
017839 Project Record Documents

017900 Demonstration and Training
019113 General Commissioning Requirements
019119 Exterior Enclosure Commissioning

DIVISION 02 - EXISTING CONDITIONS

024119 Selective Demolition

DIVISION 03 - CONCRETE

034500 Precast Architectural Concrete
034900 Glass-Fiber-Reinforced Concrete (GFRC)

DIVISION 04 - MASONRY

040110 Masonry Cleaning
042200 Concrete Unit Masonry
042613 Masonry Veneer

DIVISION 05 - METALS

055000 Metal Fabrications
055050 Pipe Grid
055113 Metal Pan Stairs
055213 Pipe and Tube Railings
057300 Decorative Metal Railings

DIVISION 06 - WOOD, PLASTICS, COMPOSITES

061053 Miscellaneous Rough Carpentry
061600 Sheathing
064023 Interior Architectural Woodwork
064116 Plastic-Laminate-Clad Architectural Cabinets
064216 Flush Wood Paneling

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

071326 Self-Adhering Sheet Waterproofing
071800 Traffic Coatings
072100 Thermal Insulation
072119 Foamed-In-Place Insulation
072413 Water-Drainage Exterior Insulation and Finish System (EIFS)
072414 Direct-Applied Exterior Finish System (DEFS)
072726 Fluid-Applied Membrane Air Barriers
073113 Asphalt Shingles
074646 Fiber-Cement Siding
075419 Polyvinyl-Chloride (PVC) Roofing
076200 Sheet Metal Flashing and Trim
077100 Roof Specialties
077129 Manufactured Roof Expansion Joints
077200 Roof Accessories
078100 Applied Fireproofing
078123 Intumescent Fire Protection
078413 Penetration Firestopping

078443	Joint Firestopping
079100	Preformed Joint Sealants
079200	Joint Sealants
079219	Acoustical Joint Sealants
079513.13	Interior Expansion Joint Cover Assemblies
079516.16	Exterior Expansion Joint Cover Assemblies

DIVISION 08 - OPENINGS

081113	Hollow Metal Doors and Frames
081416	Flush Wood Doors
083113	Access Doors and Frames
083323	Overhead Coiling Doors
083344	Overhead Coiling Fire Curtains
083400	Special Function Doors
083473.16	Wood Sound Control Door Assemblies
084113	Aluminum-Framed Entrances and Storefronts
084126.23	Interior All-Glass Entrances and Storefronts All-Glass Door Hardware
084229.23	Sliding Automatic Entrances
084413	Glazed Aluminum Curtain Walls
085113	Aluminum Windows
087100	Door Hardware
087105	Acoustical Door Gaskets
088000	Glazing
088300	Mirrors
088700	Glazing Surface Films
088813	Fire-Rated Glazing
089119	Fixed Louvers

DIVISION 09 - FINISHES

092116.23	Gypsum Board Shaft Wall Assemblies
092216	Non-Structural Metal Framing
092713	Glass-Fiber-Reinforced Gypsum Fabrications
092900	Gypsum Board
093013	Ceramic Tiling
095113	Acoustical Panel Ceilings
096513	Resilient Base and Accessories
096520	Resilient Plank Flooring
096543	Linoleum Flooring
096623	Resinous Matrix Terrazzo Flooring
096813	Tile Carpeting
097200	Wall Coverings
098133	Acoustical Insulation, Sealants and Accessories
098413	Fixed Sound Absorptive Panels
099113	Exterior Painting
099123	Interior Painting

VOLUME TWO

DIVISION 10 - SPECIALTIES

101100	Visual Display Units
101110	Visual Display Surfaces
101419	Dimensional Letter Signage
101423.16	Room-Identification Panel Signage
102113.17	Phenolic-Core Toilet Compartments
102239	Folding Glass-Panel Partitions
102800	Toilet Accessories
104313	Defibrillator Cabinets
104413	Fire Protection Cabinets
104416	Fire Extinguishers
105123	Plastic-Laminate-Clad Lockers
105613	Metal Storage Shelving
105626	Mobile Storage Shelving

DIVISION 11 - EQUIPMENT

115213	Projections Screens
115313	Fume Extractor Arms

DIVISION 12 - FURNISHINGS

122113	Horizontal Louver Blinds
122413	Roller Window Shades
123623.13	Plastic-Laminate-Clad Countertops
123661.16	Solid Surfacing Countertops
124813	Entrance Walk-Off Carpet

DIVISION 21 - FIRE PROTECTION

210000	General Fire Protection Requirements
211318	Fire Protection Systems

DIVISION 22 - PLUMBING

220000	General Plumbing Requirements
220529	Plumbing Supporting Devices
220553	Plumbing Systems Identification
230594	Domestic Water System Test Adjust Balance
220700	Plumbing Systems Insulation
221100	Water Distribution System
221300	Sanitary Waste and Storm Drainage Systems
222114	Plumbing Specialties
223314	Water Heating Equipment
224000	Plumbing Fixtures

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

230000	General Mechanical Requirements
230528	Mechanical Supporting Devices

230550 Vibration Isolation
230553 Mechanical Systems Identification
230594 Water Systems Test Adjust Balance
230596 Air Systems Test Adjust Balance
230700 Mechanical Systems Insulation
230901 Control Systems Integration
230902 Control Valves and Dampers
230903 Controls Instrumentation
230993 Control Sequences
232116 Pipe and Pipe Fittings
232118 Valves
232120 Piping Specialties
232514 Chemical Treatment Systems
233114 Ductwork
233314 Ductwork Specialties
233400 Fans
233600 Air Terminal Devices
233713 Diffusers, Registers and Grilles
238129 Variable Refrigerant Flow System Equipment
238214 Heating and Cooling Terminal Devices
238413 Humidification Equipment

DIVISION 26 - ELECTRICAL

260000 General Electrical Requirements
260519 Low-Voltage Electrical Power Conductors and Cables
260526 Grounding and Bonding for Electrical Systems
260527 Lightning Protection System
260529 Hangers and Supports for Electrical Systems
260530 Floor and Wall Boxes
260533 Raceway and Boxes for Electrical Systems
260533.13 Surface Raceway System
260543 Underground Ducts and Raceways for Electrical Systems
260553 Electrical Identification
260593 Electrical Systems Firestopping
260801 Power Distribution Acceptance Tests
260923 Conventional Lighting Control Devices
260936 Modular Digital Lighting Control Systems
262200 Low-Voltage Transformers
262400 Switchboards
262413 Panelboards
262513 Track Busway
262713 Electrical System Metering
262726 Wiring Devices
262816 Enclosed Switches and Circuit Breakers
262913 Motor Controllers
263213 Engine Generators
263623 Automatic Transfer Switch
264300 Surge Protective Devices (SPDs)
265000 Lighting

DIVISION 27 - COMMUNICATIONS

270000 General Communications Requirements

270526 Grounding and Bonding for Communications Systems
270528.29 Hangers and Supports for Communications Systems
270528.33 Raceway and Boxes for Communications Systems
270528.36 Cable Trays for Communications Systems
270553 Communications Systems Identification
271000 Structured Cabling
271100 Communications Equipment Room Fittings
271300 Communications Backbone Cabling
271500 Communications Horizontal Cabling
275129 Two-Way Communication System
275319 Emergency Responder Radio Reinforcement System

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

280000 General Electronic Safety and Security Requirements
280513 Conductors and Cables for Electronic Security
281300 Access Control
282300 Video Surveillance System
283116 Multiplexed Fire Detection and Alarm Systems

DIVISION 32 - EXTERIOR IMPROVEMENTS

321400 Unit Paving
321443 Porous Unit Paving
323300 Site Furnishings
328400 Landscape Irrigation System
329200 Turf and Grasses
329300 Plants

END OF TABLE OF CONTENTS

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass markerboards.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.

B. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.

C. Product Schedule: For visual display units.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each visual display unit, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For visual display units to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings. Include accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings 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.

PART 2 - PRODUCTS

2.1 GLASS MARKERBOARDS **(MB)**

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. Claridge Products and Equipment; Glass Markerboard with Invisi-Mount (Basis of Design)
2. AARCO Products.
3. ADP Lemco.
4. Best-Rite Manufacturing.
5. Clarus Glassboards, Inc.
6. Ghent Manufacturing, Inc.
7. Krystal Glass Writing Boards.

B. Glass Markerboards: Fabricated of 6-mm tempered low-iron glass with steel backing for use with magnets.

1. Edge Treatment: Smooth polished edge with eased corners.
2. Surface: Glossy.
3. Color: White.

C. Mounting: Concealed, Z-shaped brackets.

D. Size: As indicated on Drawings.

2.2 MATERIALS

A. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine walls and partitions for proper preparation and backing for visual display units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

D. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.

3.3 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Factory-Fabricated Visual Display Board Assemblies: Attach in accordance with manufacturer's written instructions.

3.4 CLEANING AND PROTECTION

A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 101100

SECTION 101110 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Visual Display Surfaces.

1.2 DEFINITIONS

A. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.

1. Show locations of panel joints.
2. Show locations of special-purpose graphics for visual display surfaces.
3. Include sections of typical trim members.

C. Samples: For each type of visual display surface indicated.

1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.

D. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.

C. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display surfaces to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

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. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate appearance and aesthetic effects and set quality standards for installation.

1. Build mockup of typical wall area as shown on Drawings. Include accessories.
2. Approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings 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.

1.9 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace visual display surfaces that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Resilient Tackable Surface Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto natural jute backing; with washable finish and integral color throughout with surface-burning characteristics indicated.

B. Hardboard: ANSI A135.4, tempered.

C. Particleboard: ANSI A208.1, Grade M-1.

D. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.2 TACKBOARD ASSEMBLIES **(TACK-1)**

A. Resilient Tackable Surface Sheet: 1/4-inch-thick, homogenous sheet for direct wall application.

1. Corners: As indicated on Drawings.
2. Width: As indicated on Drawings.
3. Height: As indicated on Drawings.
4. Mounting: Wall.
5. Mounting Height: As indicated on Drawings.
6. Edges: Concealed by extruded aluminum trim.

B. Color: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer.

B. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Section 099113 "Interior Painting" and recommended in writing by visual display surface manufacturer for intended substrate.

C. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch-thick, extruded aluminum; of size and shape indicated on Drawings.

1. Field-Applied Trim: Install with no visible screws or exposed joints.

2.4 FABRICATION

A. Visual Display Surfaces: Factory cut visual display surfaces into shapes indicated.

1. Make joints only where total width exceeds maximum manufactured width. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
2. If butt joints are required by the design, they shall fit tight to minimize visibility.
3. Provide aluminum edge trim as indicated.

B. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. 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.

2.6 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.

C. Examine walls and partitions for proper preparation and backing for visual display surfaces.

D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

1. Prime wall surfaces indicated to receive direct-applied, visual display tack wall panels, visual display wall coverings and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
2. Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.

a. Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
b. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.

D. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawing. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.4 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated, sliding visual display units.

END OF SECTION 101110

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.

a. Cast dimensional characters.

B. Owner-Provided Signage: The Owner shall furnish and install exterior building signage not indicated on Drawings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

C. Samples: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.

b. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 DIMENSIONAL CHARACTERS

A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A. R. K. Ramos
b. Avalis Wayfinding Solutions
c. Best Manufacturing
d. Matthews International, Inc.
e. Metallic Arts, Inc.
f. Signage Industries Corporation

2. Character Material: Cast aluminum.
3. Character Height: 14 inches.
4. Graphic Content: Building identification (numbering) as required by code including, but not limited to, street address and building number.
5. Thickness: Manufacturer's standard for size of character.
6. Finishes:

a. Powder-Coat Finish: Manufacturer's standard in bronze finish when mounted on white fascia, and in white finish when mounted on brick.

7. Mounting: Projecting studs.
8. Typeface: As selected by Architect from manufacturer's standard options.

2.2 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. Sign Mounting Fasteners:

a. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.

B. Adhesive: As recommended by sign manufacturer.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.4 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. 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.

2.6 ALUMINUM FINISHES

A. Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

B. Owner-Provided Signage: The Owner shall furnish and install interior room identification signage and exterior building signage not indicated on Drawings including, but not limited to, wayfinding and department signage.

1.2 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.3 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ASI Sign Systems, Inc.
b. Best Manufacturing Company
c. Corum Signs, Inc.
d. Signature Signs
e. 2/90 Sign Systems

2. General: Provide signs as indicated on Drawings, or as required by code, including but not limited to, toilet rooms, stairs, elevators, exits, electrical rooms, and assembly spaces.

a. Provide graphics and Braille as required by code.
b. Fabricate panel signs to comply with the requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes and details of construction. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed condition within a tolerance of plus or minus 1/16 inch measured diagonally.

3. Unframed Panel Signs: Fabricate unframed panel signs with edges mechanically and smoothly finished to conform with the following requirements:

a. Edge Condition: Beveled.

b. Corner Condition: Provide corners rounded to 1/2-inch radius.
c. Signs: Nominal 3/16-inch-thick, plastic or phenolic, with the following:

1) Raised characters, 1/32 inch minimum, at least 5/8-inch-high but not higher than 2 inches.
2) Raised numbers, 1/32 inch minimum, at least 1-inch high numbers;
3) Raised Braille, 1/32 inch minimum, Grade 2;
4) Signs shall be etched and have raised integral symbols and letters. Applied symbols and letters are not acceptable.
5) Each room sign shall list the room number and a room identification name in both Braille and in the characters and numbers described above.

d. Character Font: As selected by Architect.
e. Size: Provide typical 8 by 8 inch size, unless otherwise noted on the Drawings or as needed to meet requirements.
f. Exterior Signs: Provide fiberglass units for exterior applications.

1) Provide red fire pump room signage as required by code and indicated on Drawings.

g. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

1) Color: Color matching sign or black. Confirm final color selection with Architect.

h. Copy for each sign shall be provided during the Construction Phase of the project.
i. Handicapped Symbols: Provide one combination handicapped symbol, male and female caricatures, and room identification sign for every room where handicapped facilities are provided, such as toilet rooms.
j. Color: Color for background and letter colors as selected by Architect from manufacturer's full range in non-glare finish.
k. Mounting Height Above Floor: 48 inches minimum above floor measure to baseline of lowest raised character and 60 inches maximum above floor measured to baseline of highest raised character.

2.3 SIGN MATERIALS

A. Plastic Laminate: Provide high-pressure laminate engraving stock with face and core plies.

1. Color: As selected by Architect from manufacturer's full range.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.

B. Adhesive: As recommended by sign manufacturer.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.

C. Mounting Methods:

1. Interior Signage: Manufacturer's standard two-face tape and silicone-adhesive mounting, unless otherwise indicated.

a. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
b. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

2. Exterior Signage: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Phenolic-core toilet compartments configured as toilet enclosures and urinal screens.

1.2 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 toilet compartments.

B. Shop Drawings: For toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show overhead support or bracing locations.

C. Samples: For each type of toilet compartment material indicated.

D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25or less.

2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 PHENOLIC-CORE TOILET COMPARMENTS

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:

1. ASI Accurate Partitions.
2. ASI Global Partitions.
3. Bobrick Washroom Equipment.
4. Bradley Corp.
5. General Partitions Mfg. Corp.
6. Metpar Corp.

B. Toilet-Enclosure Style: Overhead braced, floor anchored

C. Urinal-Screen Style: Wall hung, floor anchored.

D. Door, Panel, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- thick doors and pilasters and minimum 1/2-inch- thick panels.

E. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

F. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters with shoe matching that on the pilaster.

G. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, stainless steel.

H. Phenolic-Panel Finish:

1. Facing Sheet Finish: One color and pattern in each room.
2. Color and Pattern: As selected by Architect from manufacturer's full range with manufacturer's standard through-color core matching face sheet.
3. Edge Color: Through-color matching facing sheet color.

2.3 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Manufacturer's minimum 0.062-inch- thick stainless steel paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door. Mount with through-bolts.
2. Latch and Keeper: Manufacturer's heavy-duty surface-mounted cast-stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.

3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
4. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless steel bumper at out-swinging doors. Mount with through-bolts.
5. Door Pull: Manufacturer's heavy-duty cast-stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: ASTM B221.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

D. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at bottoms of posts. Provide shoes at posts to conceal anchorage.

E. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels: 1/2 inch.
b. Panels and Walls: 1 inch.

2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.

a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.17

SECTION 102239.13 - FOLDING GLASS-PANEL PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes manually operated, glass-panel partitions.

1.2 DEFINITIONS

A. STC: Sound Transmission Class.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For operable glass-panel partitions.

1. Include plans, elevations, sections, details, numbered panel installation sequence, and attachments to other work.
2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.

C. Samples: For each type of exposed material, finish, covering, or facing.

1. Include Samples of accessories involving color selection.

D. Delegated-Design Submittal: For operable glass-panel partitions.

1. Include design calculations for seismic restraints that brace tracks to structure above.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Partition track, track supports and bracing, switches, turning space, and storage layout.
2. Suspended ceiling components.
3. Structural members to which suspension systems are attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

   a. Lighting fixtures.
   b. HVAC ductwork, outlets, and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Smoke detectors.
   f. Access panels.

6. Plenum acoustical barriers.

B. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

C. Qualification Data: For qualified Installer.

D. Seismic Qualification Certificates: For operable glass-panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:

1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, according to ASCE/SEI 7.
2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of operable glass-panel partition.

F. Product Test Reports: For each operable glass-panel partition, for tests performed by a qualified testing agency.

G. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For operable glass-panel partitions to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Panel finish and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
b. Seals, hardware, track, track switches, carriers, and other operating components.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of operable glass-panel partitions that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of operable glass-panel partitions.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: Two years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing of tracks to structure above.

B. Seismic Performance: Operable glass-panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."

C. Acoustical Performance: Provide operable glass-panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:

1. Sound-Transmission Requirements: Operable glass-panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.

D. Fire-Test-Response Characteristics: Provide wood-framed panels complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2.2 OPERABLE GLASS PANELS

A. Operable Glass Panels: Aluminum-framed glass-panel partition system, including panels, seals, suspension system, operators, and accessories.

1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

a. Modernfold; Acousti-Clear Automatic (Basis of Design)
b. Hufcor
c. Nana Wall

B. Panel Operation: Manually operated, paired panels.

C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

1. Factory-Glazed Fabrication: Glaze operable glass panels in the factory where practical and possible for applications indicated. Comply with manufacturer's written instructions and with requirements in Section 088000 "Glazing."

D. Glass and Glazing: As follows:

1. Safety Glass Standard for Partition Panels: Glass products complying with testing requirements in 16 CFR 1201, Category II, or ANSI Z97.1, Class A.

2. Safety Glass Standard for Pass Doors: Glass products complying with testing requirements in 16 CFR 1201, Category II.
3. Glass: Manufacturer's standard safety glass and glass assemblies as indicated and complying with the following:
   a. Tempered Glass: ASTM C1048, Kind FT (fully tempered), Type I (transparent flat glass), Class 1 (clear), Quality-Q3.
   b. Glass Thickness: Manufacturer's standard thickness for indicated requirements.
   c. Glass Vertical Edge: Polished.
4. Glazing System: Manufacturer's standard factory-glazing system that produces acoustical seal.

E. Dimensions: Fabricate operable glass-panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
   1. Panel Width: Equal widths.

F. STC: Not less than 45.

G. Panel Weight: 11 lb/sq. ft. maximum.

H. Panel Frame Thickness: Nominal dimension of 4 inches.

I. Panel Frame Materials:
   1. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; ASTM B221 for extrusions; manufacturer's standard strengths and thicknesses for type of use.
      a. Frame Reinforcement: Manufacturer's standard steel or aluminum.

J. Panel Closure: Manufacturer's standard unless otherwise indicated.

K. Hardware: Manufacturer's standard as required to operate operable glass-panel partition and accessories; with decorative, protective finish.
   1. Hinges: Manufacturer's standard.
   2. Floor Lock: Key actuated.

L. Panel Frame Finishes: Clear anodized aluminum.

2.3 SEALS

A. Description: Seals that produce operable glass-panel partitions complying with performance requirements and the following:
   1. Manufacturer's standard seals unless otherwise indicated.
   2. Seals made from materials and in profiles that minimize sound leakage.
   3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable glass-panel partition perimeter and adjacent surfaces, when operable glass-panel partition is extended and closed.

2.4 SUSPENSION SYSTEMS

A. Tracks: Steel or aluminum with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable glass-panel partition indicated. Size track to support partition operation and

storage without damage to suspension system, operable glass-panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

1. Panel Guide: Aluminum guide on both sides of the track to facilitate straightening of the panels; finished with factory-applied, decorative, protective finish.
2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.

B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

1. Multidirectional Carriers: Capable of negotiating intersections without track switches.

C. Track Intersections, Switches, and Accessories: As required for operation, storage, track configuration, and layout indicated for operable glass-panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.

1. L Intersections: Allow panels to change 90 degrees in direction of travel.
2. T Intersections: Allow panels to pass through or change 90 degrees to another direction of travel.
3. X Intersections: Allow panels to pass through or change travel direction full circle in 90-degree increments, and allow one partition to cross track of another.
4. Multidirectional Switches: Adjustable switch configuring track into L, T, or X intersections and allowing panels to be moved in all pass-through, 90-degree change, and cross-over travel direction combinations.
5. Center carrier stop.

D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

E. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.5 ACCESSORIES

A. Pass Doors: Swinging door built into and matching panel materials, construction, acoustical qualities, finish and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.

1. Accessibility Standard: Fabricate doors to comply with applicable provisions in ICC A117.1.
2. Single Pass Door: 36 by 84 inches.
3. Pass-Door Hardware: Equip pass door with the following:

a. Door Seals: Mechanically operated floor seal on panels containing pass doors.
b. Panic hardware.
c. Concealed door closer.
d. Latchset: Passage set.
e. Lock: Key-operated lock with cylinder, keyed to master key system, operable from both sides of door. Include two keys per lock.
f. Lock: Deadlock to receive cylinder, operable from both sides of door. See Section 087100 "Door Hardware" for lock cylinder and keying requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable glass-panel partitions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install operable glass-panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.

B. Install panels in numbered sequence indicated on Shop Drawings.

C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

E. Light-Leakage Test: Temporarily opacify glass areas of panels. Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids. Adjust partitions for alignment and full closure of vertical joints and full closure along top and bottom seals.

3.3 ADJUSTING

A. Adjust operable glass-panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pass doors to operate smoothly and easily, without binding or warping.

C. Verify that safety devices are properly functioning.

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Final Acceptance, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operable-partition operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable glass-panel partitions.

END OF SECTION 102239.13

SECTION 102800 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Childcare accessories.
3. Custodial accessories.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. Bobrick Washroom Equipment, Inc. (Basis of Design)
2. A & J Washroom Accessories, Inc.
3. American Specialties, Inc.
4. Bradley Corporation

2.2 OWNER-FURNISHED, CONTRACTOR-INSTALLED MATERIALS

A. Owner-Furnished, Contractor-Installed Materials:

1. Toilet Paper Dispenser, VonDrehle, T300 Series Twin Jumbo Tissue Dispenser
2. Hand Towel Dispenser, Tork+PeakServe Model 552520
3. Soap Dispenser, To Be Determined.
4. Sanitary Napkin Disposal, To Be Determined.

2.3 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.

B. Grab Bar **(GB18, GB36, GB42)**:

1. Basis of Design: Bobrick; B-6806.99
2. Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
3. Mounting: Flanges with concealed fasteners.
4. Material: Stainless steel, 0.05 inch thick.
   a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin)
5. Outside Diameter: 1-1/2 inches.
6. Configuration and Length: As indicated on Drawings

2.4 CHILDCARE ACCESSORIES

A. Source Limitations: Obtain each type of childcare accessory from single source from single manufacturer.

B. Diaper-Changing Station **(DCS)**:

1. Basis of Design: Koala Kare; KB300
2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
   a. Engineered to support minimum of 250-lb static load when opened.
3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
4. Operation: By pneumatic shock-absorbing mechanism.
5. Material and Finish: HDPE in manufacturer's standard color.

2.5 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain each type of custodial accessory from single source from single manufacturer.

B. Custodial Mop and Broom Holder **(MH**):

1. Basis of Design: Bobrick; B-224 x 36
2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches.
4. Hooks: Three.
5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
   a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
   b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.6 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.

B. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

C. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

2.7 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104313 - DEFIBRILLATOR CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinets for automatic external defibrillators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cabinets.

1. Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Shop Drawings: For defibrillator cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Product Schedule: For defibrillator cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final defibrillator cabinet schedule with defibrillator schedule to ensure proper fit and function.

1.3 COORDINATION

A. Coordinate size of defibrillator cabinets to ensure that type and size of defibrillators indicated are accommodated.

B. Coordinate sizes and locations of defibrillator cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:

1. ZOLL Medical Corporation (Basis of Design)
2. Cardiac Science Corporation
3. Defibtech, LLC.
4. Heart Sine Technologies, Inc.
5. Philips Healthcare Division of Philips Electronics, NV
6. Welch Allyn, Inc.

2.2 DEFIBRILLATOR CABINET

A. Cabinet Type: Suitable for automatic external defibrillator.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

D. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

1. Square-Edge Trim.

E. Cabinet Trim Material: Steel sheet.

F. Door Material: Steel sheet.

G. Door Style: Fully glazed panel with frame.

H. Door Glazing: Tempered float glass (clear).

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide manufacturer's standard.
2. Provide continuous hinge, of same material and finish as trim permitting door to open 180 degrees.

J. Accessories:

1. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
2. Identification: Identify defibrillator in cabinet with the words "EMERGENCY DEFIBRILLATOR."
3. Alarm: Manufacturer's standard local alarm that actuates when defibrillator cabinet door is opened and that is powered by low voltage, complete with transformer.
4. Projecting Signage: Wall mounted, V-shaped projecting AED sign.

a. Material: Polished acrylic, 120 mils thick.
b. Text and Graphics: Manufacturer's standard text and graphics, including but not limited to, the words "Automated External Defibrillator", a defibrillator symbol, and an arrow pointing to defibrillator cabinet location.
c. Size: 6 inches high by 8 inches wide by 5 inches projecting from the wall.

K. Finishes: Powder coat.

1. Color: As selected by Architect from manufacturer's full range.

2.3 MATERIALS

A. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.

B. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 FABRICATION

A. Defibrillator Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.

2. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames of one-piece construction with edges flanged.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of defibrillator cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish defibrillator cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. 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.

2.6 STEEL FINISHES

A. Surface Preparation: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semirecessed defibrillator cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install defibrillator cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Defibrillator Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide semirecessed cabinets.
2. Fasten mounting brackets to inside surface of cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as defibrillator cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust defibrillator cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of defibrillator cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace defibrillator cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by defibrillator cabinet and mounting bracket manufacturers.

E. Replace defibrillator cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104313

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for portable fire extinguisher.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.3 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

C. Provide fire rated cabinets where indicated to be installed in fire rated walls.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Amerex Corporation
2. Ansul Incorporated; Tyco International
3. Babcock-Davis
4. Badger Fire Protection; a Kidde company
5. JL Industries
6. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
7. Larsens Manufacturing Company
8. Potter Roemer LLC

B. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

B. Cabinet Construction: Rated and nonrated as required to match rating of wall assembly.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch- thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Cold-rolled steel sheet.

1. Shelf: Same metal and finish as cabinet.

D. Recessed Cabinet **(FEC1)**:

1. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.

E. Semirecessed Cabinet **(FEC2)**: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

1. Rolled-Edge Trim: 2-1/2-inch backbend depth.

F. Cabinet Trim Material: Steel sheet.

G. Door Material: Steel sheet.

H. Door Style:

1. Recessed Cabinet: Flush opaque panel, frameless, with no exposed hinges.
2. Semirecessed Cabinet: Vertical duo panel with frame.

I. Door Glazing: Tempered float glass (clear).

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting lever handle with cam-action latch.
2. Provide concealed hinge, permitting door to open 180 degrees.

K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.

3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
   a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
      1) Location: Applied to cabinet door or cabinet glazing.
      2) Application Process: Decals or pressure-sensitive vinyl letters.
      3) Lettering Color: Red.
      4) Orientation: Vertical.
4. Projecting Signage: Wall mounted, V-shaped projecting fire extinguisher sign.
   a. Material: Polished acrylic, 120 mils thick.
   b. Text and Graphics: Manufacturer's standard text and graphics, including but not limited to, the words "Fire Extinguisher", a symbol of a fire extinguisher, and an arrow pointing to fire extinguisher cabinet location.
   c. Size: 6 inches high by 8 inches wide by 5 inches projecting from the wall.

L. Materials:
1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
   a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
   b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   c. Color: As selected by Architect from manufacturer's full range.
2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification: Apply vinyl lettering and projecting signage in accordance with manufacturer's written installation instructions.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.
2. Provide fire extinguishers in elevator mechanical/control rooms that comply with North Carolina Department of Labor requirements.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.
b. Ansul Incorporated; Tyco International Ltd.
c. Badger Fire Protection; a Kidde company.
d. J.L. Industries, Inc.
e. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
f. Larsen's Manufacturing Company.
g. Potter-Roemer; Div. of Smith Industries, Inc.

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Manufacturer's standard.
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Carbon Dioxide Type: UL-rated 10-B:C, 10-lb nominal capacity, with carbon dioxide in manufacturer's standard enameled-metal container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets **(FEMB)**: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: Top of fire extinguisher to be at 42 inches above finished floor.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105123 - PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad wood lockers.

1.2 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 of locker.

B. Shop Drawings: For plastic-laminate-clad wood lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show details full size.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in lockers.
5. Show locker fillers, trim, base, and accessories.
6. Show locker identification system and numbering sequence.

C. Samples: For high-pressure decorative laminates.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

B. Deliver combination control charts to Owner by registered mail or overnight package service.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install lockers until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during the remainder of the construction period.

B. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.

1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.8 COORDINATION

A. Coordinate sizes and locations of concealed cold form metal framing support bases.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of locks or hardware.
c. Deterioration of wood, finishes, and other materials beyond normal use.

2. Warranty Period: Three years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. Ideal Products, Inc.; Ideal 2000 Series (Basis of Design)
2. Hollman, Inc.
3. Legacy Lockers
4. Summit Lockers

B. Construction Style: Flush overlay.

C. Final Assembly: Manufacturer's standard factory or knocked-down assembly.

D. Locker Body: Fabricated from fire-retardant-particleboard-core panels covered on both sides with thermoset decorative overlay.

1. Side Panels: Manufacturer's standard 3/4 or 5/8 inch thick.
2. Back Panel: Manufacturer's standard 1/2 or 3/8 inch thick.
3. Top Panel: Manufacturer's standard 3/4 or 5/8 inch thick.
4. Bottom Panel: Manufacturer's standard 3/4 or 5/8 inch thick.
5. Exposed Panel Edges: High-pressure decorative laminate, Grade VGS, to match panels.

E. Plastic-Laminate-Clad Wood Doors: High-pressure decorative laminate, Grade VGS, over both sides of fire-retardant-particleboard or fire-retardant-fiberboard core.

1. Thickness: Manufacturer's standard 3/4 or 5/8 inch thick.
2. Panel Edges: High-pressure decorative laminate, Grade VGS, to match panels.

F. End Panels: Match style, material, construction, and finish of plastic-laminate-clad wood doors.

G. Shelves: Fabricated from fire-retardant-particleboard-core panels covered on both sides with thermoset decorative overlay; fixed.

1. Thickness: 3/4 inch.
2. Exposed Edges: Thermoset decorative overlay to match panels.

H. Corners and Filler Panels: 3/4-inch- thick panels. Match style, material, construction, and finish of plastic-laminate-clad wood doors.

I. Continuous Finish Base: Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces; fabricated in lengths as long as practical to enclose base and base ends of lockers.

J. Plastic-Laminate Colors, Patterns, and Finishes:

1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:

a. Formica; Neutral Weft Matte Finish, 5874-58 (Basis of Design)
b. Nevamar; a Panolam Industries International, Inc. brand
c. Pionite; a Panolam Industries International, Inc. brand.
d. Wilsonart

2.3 MATERIALS

A. Composite Wood: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
3. Particleboard: ANSI A208.1, Grade M-2.

B. High-Pressure Decorative Laminate: NEMA LD 3, grades as follows:

1. Horizontal Surfaces: Grade HGS.
2. Vertical Surfaces: Grade VGS.

C. Fire-Retardant-Treated Materials: Where fire-retardant-treated materials are indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to authorities having jurisdiction to produce products with fire-test-response characteristics specified.

1. Do not use material that is warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.
3. Fire-Retardant Particleboard: Panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less according to ASTM E84:

   a. Panels 3/4 Inch Thick and Less: ANSI A208.1, Grade M-2, except for the following minimum properties: density, 45 lb/cu. ft.; modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
   b. Panels 13/16 to 1-1/4 Inches Thick: ANSI A208.1, Grade M-1, except for the following minimum properties: density, 44 lb/cu. ft.; modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.

4. Fire-Retardant Fiberboard: Medium-density panels according to ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less according to ASTM E84.

D. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

E. Anchors: Material, type, size, and finish as required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

F. Cold-form Metal Framing Support Base: 3-5/8” cold form metal framing with ½” fire-resistance treated plywood.

2.4 HARDWARE

A. Digital Keypad Lock: Battery-powered electronic keypad with reprogrammable manager and owner codes that override access. Three consecutive incorrect code entries shall disable lock for three minutes.

1. Designed for shared or temporary access by multiple users, with user-defined code to lock and unlock. Provide LED indicator to show when lock is in use.

B. Frameless Hinges (European Type): Fully concealed, nickel-plated steel, with not less than 125 degrees of opening.

1. Provide two hinges for doors 36 inches high and less.

2. Provide three hinges for doors more than 36 inches high.

C. Accessible Handle: Metal, fixed, graspable lever handle; surface mounted.

D. Hooks: Manufacturer's standard, ball-pointed aluminum or steel; finished to match other locker hardware. Attach hooks with at least two fasteners.

1. Provide two single-prong wall hooks for each compartment of double-tier lockers.

E. Exposed Hardware Finish: As selected by Architect from manufacturer's standard selections.

2.5 ACCESSORIES

A. Number Identification Plates: 1-1/2-inch- diameter, etched, embossed, or stamped, stainless-steel plates with black numbers and letters at least 1/2 inch high. Identify lockers in sequence approved by Architect.

2.6 FABRICATION

A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.

1. Fabricate lockers to dimensions, profiles, and details indicated.
2. Ease edges of corners of solid-wood members to 1/16-inch radius.

B. Fabricate lockers square, rigid, without warp, and with finished faces flat and free of dents, scratches, and chips. Accurately factory machine components for attachments. Make joints tight and true.

1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.

C. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks or additional shelves are provided, locate no higher than 48 inches above the floor.

D. Number Identification Plates: Inlay number plates flush in each locker door, near top, centered.

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Use only manufacturer's nuts, bolts, screws, and other devices for assembly.

F. Shop cut openings, to maximum extent possible, to receive hardware and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Condition lockers to average prevailing humidity conditions in installation areas before installation.

B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

A. Install wood support base.

B. Install lockers level, plumb, and true; use concealed shims.

C. Connect groups of lockers together with manufacturer's standard fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.

D. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.

E. Locker Anchorage:

1. Fasten lockers through back, near top and bottom, at ends with No. 8 flush-head wood screws sized for 1-inch penetration into wood framing, blocking, or furring and spaced not more than 16 inches o.c.

F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.

G. Install number identification plates after lockers are in place.

1. Attach number identification plate on each locker door, near top, centered, with at least two screws with finish matching the plate.

3.4 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding. Verify that integral locking devices operate properly.

3.5 PROTECTION

A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105123

SECTION 105613 - METAL STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Four-post metal storage shelving.

1.2 COORDINATION

A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.

B. Coordinate locations and installation of metal storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal storage shelving.

B. Shop Drawings: For metal storage shelving.

1. Include plans, elevations, sections, and attachment details.
2. Include installation details of connectors, lateral bracing, and special bracing.

C. Samples: For each type of metal storage shelving with factory-applied color finishes.

1. Include Samples of accessories involving color selection.

D. Product Schedule: For metal storage shelving.

E. Delegated-Design Submittal: For seismic restraint of metal storage shelving.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For metal storage shelving, accessories, and components, from manufacturer.

C. Product Certificates: For each type of metal storage shelving.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal storage shelving to include in maintenance manuals.

1.6 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. Shelves: Full-size units equal to 0.5 percent of amount installed for each type indicated, but no fewer than 5 shelves.
2. Shelf-to-Post Connectors: Full-size units equal to 0.5 percent of amount installed for each type indicated, but no fewer than 10 connectors.
3. Shelf-Label Holders: Full-size units equal to 0.5 percent of amount installed for each type indicated, but no fewer than 10 holders.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install metal storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal storage shelving, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Metal storage shelving shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Component Importance Factor: 1.0.

2.2 FOUR-POST METAL STORAGE SHELVING

A. Four-Post Metal Storage Shelving: Complying with MH 28.1 and field assembled from factory-formed components. Shelves span between supporting corner posts that allow shelf-height adjustment over full height of shelving unit. Provide fixed top and bottom shelves, adjustable intermediate shelves, and accessories indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lyon Workspace Products, LLC.
b. Shure Mfg. Corp.
c. Spacesaver.
d. Wenger Corporation, JR Clancy and GearBoss.

2. Load-Carrying Capacity per Shelf: 700 lb.
3. Posts: Fabricated from hot-rolled steel; in manufacturer's standard shape; with perforations at 1-1/2 inches o.c. to receive shelf-to-post connectors.

a. Unit Configuration: Configure shelving units as individual assemblies.
b. Post Base: Bolt leveler.

4. Bracing: Manufacturer's standard, double diagonal cross bracing.

   a. Location: At unit back as required for stability, load-carrying capacity of shelves, and number of shelves indicated.

5. Back Panel: One piece fabricated from cold-rolled steel sheet.

   a. Steel Sheet Thickness, Nominal: 0.024 inch.

6. End Panels: Fabricated from cold-rolled steel sheet.

   a. Steel Sheet Thickness, Nominal: 0.024 inch.

7. Solid-Type Shelves:

   a. Steel Sheet: Nominal thickness as required for load-carrying capacity per shelf.
   b. Slots or Holes for Shelf Dividers: 3 inches o.c.
   c. Fabricate fronts and backs of shelves with vertical edges that are flanged and returned, with edges reinforced with steel bars, angles or channels.

8. Shelf Quantity: As indicated on Drawings.
9. Shelf-to-Post Connectors: Manufacturer's standard connectors.
10. Base: Closed, with base strips fabricated from same material and with same finish as shelving.
11. Overall Unit Width: As indicated on Drawings.
12. Overall Unit Depth: As indicated on Drawings.
13. Overall Unit Height: As indicated on Drawings.
14. Accessories:

   a. Finished End Panels: Double wall 0.048 inch thick cold-rolled steel sheet and with same finish as posts. Fabricated as solid full-height panels.
   b. Shelf Dividers: Fabricated from same material and with same finish as shelves.
   c. Shelf-Label Holders: Clear plastic, designed to clip onto front edge of shelf.
   d. Art Storage Dividing Rods: Stainless steel rods at front and back of shelf, six pairs per shelf.

15. Steel Finish: Baked enamel or powder coat.

   a. Color: As selected by Architect from manufacturer's full range.

2.3 ANCHORS

A. Floor Anchors: Galvanized-steel, post-installed expansion anchors. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.

B. Wall Anchors: Manufacturer's standard, galvanized-steel anchors designed to secure metal storage shelving to adjacent wall. Provide two per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.4 FABRICATION

A. Fabricate metal storage shelving components to provide field-assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.

   1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

2. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
3. Cut, reinforce, drill, and tap metal fabrications to receive hardware, fasteners, and similar items.

B. Form metal in maximum lengths to minimize joints. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

C. Form edges and corners free of sharp edges or rough areas. Fold back and crimp exposed edges of unsupported sheet metal to form a hem on the concealed side; ease edges of metal plate to radius of approximately 1/32 inch. Shear and punch metals cleanly and accurately. Remove burrs.

D. Weld corners and seams continuously to develop strength, minimize distortion, and maintain the corrosion resistance of base metals. At exposed locations, finish welds and surfaces smooth and blended so surface is smooth after finishing and contour of welded surface matches that of adjacent surface. Weld before finishing components to greatest extent possible. Remove weld spatter and welding oxides from exposed surfaces before finishing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine floors for suitable conditions where metal storage shelving will be installed.

C. Examine walls to which metal storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Vacuum and clean finished floor over which metal storage shelving is to be installed.

3.3 INSTALLATION

A. Install metal storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.

1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
3. Adjust post-base bolt leveler to achieve level and plumb installation.
4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
5. Install seismic restraints.
6. Connect side-to-side and back-to-back shelving units together.
7. Install shelves in each shelving unit at equal spacing.

    a. Four-Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.

B. Accessories:

1. Install finished end panels and trim at exposed ends of shelving units.
2. Shelf Dividers: Place loose on shelves.
3. Art Storage Dividing Rods: Install as directed by Owner or Architect.

3.4 ERECTION TOLERANCES

A. Erect four-post metal storage shelving to a maximum tolerance from vertical of 1/2 inch in up to 10 feet of height, not exceeding 1 inch for heights taller than 10 feet.

3.5 ADJUSTING

A. Adjust metal storage shelving so that connectors and other components engage accurately and securely.

B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.

C. Touch up marred finishes or replace metal storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.

D. Replace metal storage shelving components that have been damaged beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 105613

SECTION 105626 - MOBILE STORAGE SHELVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanically assisted systems.
2. Steel four-post shelving.

B. Products Furnished but Not Installed Under This Section:

1. Inserts in cast-in-place concrete.

1.2 COORDINATION

A. Recessed Tracks: Coordinate size and location of recesses and inserts in concrete with installation of recessed tracks.

B. Coordinate with work of Section 033000 "Cast-In-Place Concrete."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include mobile operation, construction details, material descriptions, dimensions of individual components and profiles, and finishes for mobile storage shelving systems and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Show shelving layout.
3. Field verify finish dimensions prior to installation.
4. Show location and extent of rail system including depth required if recessed.
5. Show clear-aisle widths from face of carriages.
6. Detail fabrication and installation of mobile shelving systems including methods of anchoring shelves to carriages and rails to building structure as required for seismic restraint.

C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

D. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Seismic Design Calculations: For seismic design of mobile storage shelving systems including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mobile shelving systems and operating manuals to include in maintenance manuals.

1.7 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. Shelf Units: 0.5 percent of each size and type of adjustable shelf.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating mobile storage shelving that meets or exceeds performance requirements indicated and of documenting this performance by test reports, and calculations.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of support rail anchors, depressed slab, embedded conduit, and other construction contiguous with mobile storage shelving by field measurements before fabrication.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of mobile shelving systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, and other materials beyond normal wear.

2. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain mobile storage systems including shelving from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Seismic Performance: Mobile shelving systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 without overhead bracing.

C. Structural Performance: Provide mobile shelving systems capable of supporting the following:

1. Load per Linear Foot of Carriage: 1000 lb/ft.

D. Operating Force: For manually operated systems, maximum 1 lbf required to move 4000 lb.

2.3 SYSTEMS AND COMPONENTS

A. General: Provide manufacturer's standard mobile storage shelving systems and components. Where components are not otherwise indicated, provide manufacturer's standard components as required for a complete system.

1. The system consists of manufacturer storage units designed for library use mounted on manufacturer's track-guided carriages to form a compact storage system. System design permits access to any single aisle by moving units until the desired aisle is opened. The carriage/rail system provides uniform carriage movement along the total length of travel, even with unbalanced loads.

B. Inserts: Furnish required concrete inserts and similar anchorage devices for installing track system, and furnish other components of work where installation of devices is specified in another Section.

C. Flooring: Concrete floor thickness required to bring floor finish flush with rail tops.

D. Tracks: Steel rails with tops machined to mate with guide wheels and with ends designed to provide smooth, secure continuity between sections without field welding. Provide mounting brackets, anchorage devices, adjustable leveling devices, and stops at terminations of rails to prevent carriages from running off track ends.

1. Mounting: Recessed.
2. Minimum Contact Surface: 5/8 inch wide.
3. Provide rail sections in minimum 6-foot lengths.
4. Provide rail connections designed to provide horizontal and vertical continuity between rail sections, to gradually transfer the concentrated wheel point load to and from adjoining rail sections.
5. Rail types, quantity, and spacing to be determined by manufacturer to suit installation conditions and requirements.

E. Carriages: Rigid frames consisting of C-shaped cold-formed steel beams and cross beams, designed to allow secure anchorage of shelving units.

1. Carriage Width: As indicated on Drawings.
2. Carriage Length: As indicated on Drawings.
3. Wheels: Manufacturer's standard number of bearing-mounted, steel wheels, precision ground to mate with tracks.

a. Capacity: Minimum load capacity per wheel: 3200 lbs.
b. Size: Minimum 5 inches, outside diameter drive wheels.
c. Guides: Determined by manufacturer; minimum 2 locations.

4. Bumpers: Provide two rubber bumpers with minimum depth of 1/2 inch each side.
5. Provide fixed carriages of same construction and height as the movable carriages, anchored to rails. Setting fixed shelving directly on floors is not permitted.
6. Design carriages to allow the shelving uprights to recess and interlock into the carriages a minimum of 3/4-inch. Top mount carriages are unacceptable.

F. Anti-Tip Brackets: Mount on carriage for engagement with track system to secure units against tipping.

G. Carriage End Panels: Full depth and height of shelving units. Provide at both ends of each range.

1. Material: Cold-rolled steel sheet, 0.048 inch thick.

2.4 MECHANICALLY ASSISTED SYSTEMS

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. Spacesaver Corporation (Basis of Design)
2. Borroughs Corporation
3. Kardex Systems, Inc.
4. Montel Inc.

B. Drive Systems: Geared transmission and chain systems with tensioning device to provide mechanical assistance and uniform movement along entire length of each carriage. Permanently shielded and lubricated.

C. Drive Shaft: Continuous tubular or solid steel shaft, capable of transmitting torque from drive system without distortion.

D. Locking Pins: Located on range end panels to allow locking of individual range carriage when depressed.

2.5 STEEL FOUR-POST SHELVING

A. Steel Four-Post Shelving: Shelving consisting of four angle-iron uprights per section, with adjustable shelves resting on shelf supports hung on uprights. Configure units for mounting on mobile carriages.

B. Shelving Units:

1. Type: Self-supporting unit.
2. Configuration: Open with center dividers.
3. Width: As indicated on Drawings.
4. Height: As indicated on Drawings.
5. Shelf Depth: As indicated on Drawings.
6. Shelf Styles: Provide the following styles and numbers of adjustable shelves:

a. Flat; number of shelves as indicated on Drawings.
b. Sliding Reference Shelves: 0.048-inch-thick cold-rolled steel sheet, 3/4 to 1-inch thick, mounted on sliding extension hardware to allow shelves to retract for storage when not in use.

1) Provide one per range for single-faced units and two per range for double-faced units.

C. Uprights: Double-wall steel posts, 2 inches wide, 0.048 inch thick, in manufacturer's standard T-shape for common-post use or L-shape at range ends, with keyhole perforations on the inner wall at 1-1/2 inches o.c.

D. Steel Spacers: Provide 0.048-inch- thick steel spacers, 3 inches high, welded to posts at bottom, center, and top of open units to prevent deflection.

E. Closed Back and Ends: 0.024-inch- thick cold-rolled steel sheet.

1. Double faced shelves to be shelf through configuration.
2. Single faced fixed units to include back panels. Refer to Section 105613 "Metal Storage Shelving."

F. Center Divider: 0.024-inch- thick cold-rolled steel sheets.

G. Base: Manufacturer's standard for attachment to mobile carriages.

H. Adjustable Steel Shelves: 0.030-inch- thick cold-rolled steel sheet.

1. Shelf Supports: Full-shelf-width supports; 0.075-inch- thick steel, minimum 3/4 inches high, with flange to support shelf reinforcements and with ear at each end containing two shoulder rivets with 7/16-inch heads spaced to set into keyhole slots on uprights.
2. Shelf Reinforcements: Channel shapes equal in length to depth of the supported shelf; 0.060-inch-thick steel channels, with notched ends to fit over inside lip of shelf support.

2.6 STEEL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. 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. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to achieve a minimum dry film thickness of 2 mils.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.7 SYSTEM ACCESSORIES

A. Floor Lock: Key-operated floor lock capable of securing entire system. Provide two keys.

B. Locking Buttons: Located on range end panels to allow locking of individual range carriage when depressed. Color coded visual indicators shall provide verification that carriages are in a locked or unlocked mode.

C. Mechanical sweep and safety brake, non-powered.

D. Dual Control: Provide operating handle at each end of moveable carriages where accessed from two sides.

2.8 GROUT

A. General: Provide non-shrink, non-staining hydraulic cement compound conforming to the following requirements, based on the performance of the test specimens at room temperature and in laboratory air. Provide grout as recommended by manufacturer for interior and exterior applications.

1. Linear Movement: No shrinkage while setting; maximum expansion limited to .002 inches per linear inch.
2. Compressive Strength: Based on two-inch cubes made following ASTM standards, tested on a Balding-Southward machine of 60,000 pounds capacity, meet or exceed the following:
    a. Age: 1 hour, 4,500 psi; 7 days, 8,000 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, minimum recess depth, and other conditions affecting performance of mobile shelving systems.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Level and plumb tracks to a tolerance of 0.09 inch in 120 inches with no more than 0.06-inch variation between adjacent rails. Use permanent shims or non-shrink grout as indicated by manufacturer.

B. Recessed Track Systems: Solidly fill gaps between slab and rail according to manufacturer's written instructions to secure tracks and prevent movement.

C. Carriage Installation: Mount mobile carriages on track system with anti-tip brackets engaged by rails and adjust for smooth operation. Provide non-moving carriages securely fixed to rails where indicated.

3.3 SHELVING INSTALLATION

A. Attach shelving units to carriages according to manufacturer's written instructions and as required to prevent vibration during movement.
    1. Level and plumb shelving units to a tolerance of 1/8 inch in 96 inches.

B. Starter/Adder Units: Connect groups together with standard fasteners according to manufacturer's written instructions, using concealed fasteners where possible.

C. Install shelves in shelving units at locations indicated on Drawings and according to manufacturer's written instructions.

D. Shelving Enclosure Panels: Install end panels and canopy tops with concealed fasteners.

3.4 TESTING

A. Test each item to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

3.5 CLEANING AND PROTECTING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

C. Protect installed products from damage during remainder of the construction period.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain mobile storage shelving.

END OF SECTION 105626

SECTION 115213 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrically operated, ceiling recessed, front projection screens, controls and accessories.
2. Front projection screen controls.

B. Related Requirements:

1. Division 5 - Metal Fabrications: Suspension systems for projection screens.
2. Section 092900 - Gypsum Board Assemblies: Ceiling for recessed screen installation.
3. Section 095113 - Acoustical Tile Ceilings: Ceiling for recessed screen installation.
4. Division 26 for electrical wiring, connections, and installation of remote control switches for electrically operated projection screens.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.

1.3 DEFINITIONS

A. Gain: Indication of screen's luminance or brightness measured perpendicular of screen center and measured relative to a block of magnesium carbonate which serves as the standard for 1.0 gain. Higher numbers indicate greater brightness. Gain shall be determined in accordance with SMPTE RP 94-2000.

B. Keystone: Distortion of projected image when screen is not perpendicular with center line of projected image.

C. Viewing angle: Angle from perpendicular center of screen at which the gain or brightness is decreased by 50 percent.

1.4 SUBMITTALS

A. Submit under provisions of Section 013300 - Submittal Procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Manufacturer's installation, operation, maintenance, and cleaning instructions.

C. Wiring diagram for electrically operated units.

D. Shop Drawings: Shop drawings showing layout and types of projection screens. Show the following:

1. Location of screen centerline.
2. Location of wiring connections.

3. Detailed drawings for concealed mounting with structural support and bracing.
4. Connections to suspension systems.
5. Anchorage details.
6. Accessories.
7. Frame details.
8. Locations of low-voltage controls.

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain projection screens from single manufacturer as a complete unit including necessary mounting hardware, motor, controls, limit switches, and accessories.

B. Coordination of Work: Coordinate layout and installation of projection screens with other construction supported by, or penetrating through, ceilings, including light fixtures, HVAC equipment, fire-suppression system, and partitions.

C. Motorized projection screens shall be certified for use in the United States by Underwriters Laboratory (UL), Inc. and shall bear UL label.

D. Manufacturer Qualifications: Firm with 10 years minimum successful experience manufacturing projection screens.

E. Installer Qualifications: Authorized and trained by the manufacturer to install systems required.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver projection screens until building is enclosed, other construction within spaces where screens will be installed is substantially complete, and installation of screens is ready to begin.

B. Store products in manufacturer's original, unopened, undamaged containers with labels intact.

C. Protect screens from damage during delivery, handling, storage, and installation.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's limits.

1.8 COORDINATION

A. Coordinate work with installation of ceilings, walls, electric service power characteristics, and location.

PART 2 - PRODUCTS

2.1 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 screens of a type as defined herein shall be provided from a single manufacturer.

C. Acceptable Manufacturers:

1. Draper, Inc., 411 South Pearl Street, Spiceland, IN 47385; 765-987-7999.
2. Da-Lite Screen Company, Inc., 3100 North Detroit Street PO Box 137, Warsaw, IN 46581-0137, 574-267-8101
3. Stewart Filmscreen, 1161 Sepulveda Blvd, Torrance, CA 90502 800-762-4999
4. Requests for substitutions will be considered in accordance with provisions of Section 016000.

D. Basis of Design:

1. Items specified are to establish a standard of quality for design, function, materials, and appearance.
2. Equivalent products by listed manufacturers are acceptable.
3. The Consultant shall be the sole judge of product equivalence.

2.2 MOTORIZED SCREENS

A. Basis of Design:

1. Items specified are to establish a standard of quality for design, function, materials, and appearance.
2. The basis of design is the Draper Access FIT E

B. Type A – Motorized, ceiling recessed front projection screens

1. Electric motor operated. Ceiling recessed steel case.
2. Viewing Surface: Matte White.
3. Viewing area: See attached screen schedule.
4. UL Label: Recessed installed in return air ceiling plenums shall be certified by Underwriters Laboratory (UL), Inc. and shall bear UL label.
5. Size: See attached screen schedule.
6. Masking: Black masking borders.
7. Extra Drop Masking: See attached screen schedule
8. Seams: To the extent possible screen surfaces shall be seamless. Where required by size, provide a minimum number of flat, horizontal seams. Vertical seams are not acceptable.
9. Finish: White finished in lightly textured powder coat.
10. Low voltage control: Single Motor Low Voltage Control (LCV) capable of third-party control.
11. Wall switch: Low voltage, wall mounted, three position switch.
12. Limit switches: Pre-set, adjustable switches to automatically stop viewing surface, and case closure door where scheduled, in up or down positions.
13. Silent motor with LVC mounted inside screen roller on rubber isolation insulators. Motor operates at 44dB or better.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Coordinate provision of screens with locations of other wall and ceiling mounted components such as visual display boards, casework, structural framing, light fixtures, air diffusers, ducts, and fire sprinklers to eliminate potential conflicts

B. Coordinate provision of screens with locations of other wall and ceiling mounted components such as visual display boards, casework, structural framing, light fixtures, air diffusers, ducts, and fire sprinklers to eliminate potential conflicts.

C. Coordinate requirements for blocking, construction of recesses, and auxiliary structural supports to ensure adequate means for installation of screens.

D. Coordinate requirements for power supply, conduit, and wiring required for electric screen and controls.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Installation hardware: Provide attachment hardware, fasteners, and other components of type, size, and spacing recommended by manufacturer for complete, functional, secure installation of screens.

3.4 PROTECTION

A. Protect installed products until Final Acceptance.

B. Touch-up, repair, or replace damaged products before Final Acceptance

3.5 MOTORIZED SCREEN SCHEDULE

Room Name	Screen Type	Image Area WxH	Distance. From Bottom of Image to Finished Floor	Total Black Drop	Qty
Events	Type A	115"x65"	48"	30"	2
Computer Classroom	Type A	115"x65"	60"	12"	1
Collaboration Classroom	Type A	115"x65"	48"	24"	1

END OF SECTION 115213

SECTION 115313 - FUME EXTRACTOR ARMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fume extractor arms (snorkel).

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Indicate duct connections and electrical connections.
2. Include roughing-in information for mechanical and electrical connections.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install fume extractor arms until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for fume extractor arms.

B. Coordinate installation of fume extractor arms with ceilings, exhaust ducts, and electrical work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fume extractor arms, including attachments to other work, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. Design earthquake spectral response acceleration, short period (Sds) for Project is indicated on Structural Drawings.
2. Contractor shall verify Project's seismic design category and importance factor and provide equipment accordingly.

2.2 FUME EXTRACTOR ARMS (SNORKEL)

A. Fume Extractor Arm: Arm shall consist of 360-degree swivel elbow, support springs, friction joints with ball bearings, and dome hood.

1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:

a. Nederman; FX2 100 (Basis of Design)
b. Movex
c. Fumex

2. Air Flow: 110 - 265 cfm.
3. Tubes: 4-inch diameter, anodized aluminum.
4. Mount: Ceiling mounted.
5. Hood: Manufacturer's standard clear dome.
6. Duct Connector: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume extractor arms.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fume extractor arms according to Shop Drawings and manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building.

3.3 FIELD QUALITY CONTROL

A. Field test installed fume extractor arms to verify compliance with performance requirements.

1. Adjust fume extractor arms, exhaust fans, and building's HVAC system, and make corrections until tested fume extractor arms perform as specified.
2. After making corrections, retest fume extractor arms that failed to perform as specified.

3.4 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 115313

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal louver blinds, aluminum slats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.

C. Samples: For each exposed product and for each color and texture specified, 12 inches long.

D. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain horizontal louver blinds from single source from single manufacturer.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS **(HLB-1)**

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caco Inc.
2. Faber
3. Hunter Douglas Contract

4. Kirsch
5. Levolor Contract; a Newell Rubbermaid company
6. Springs Window Fashions

B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.

1. Width: 1 inch.
2. Thickness: Not less than 0.008 inch.
3. Spacing: Manufacturer's standard.
4. Finish: Ionized antistatic, dust-repellent, baked polyester finish.

C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.

1. Capacity: One blind(s) per headrail unless otherwise indicated.
2. Ends: Capped or plugged.
3. Manual Lift Mechanism:

   a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
   b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.

4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.

   a. Tilt: Full.
   b. Operator: Clear-plastic wand, removable type.
   c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.

5. Manual Lift-Operator and Tilt-Operator Lengths: Length of window opening height, less 3 inches.
6. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard unless otherwise indicated.

D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.

1. Type: Top contoured to match crowned shape of slat.

E. Lift Cords: Manufacturer's standard braided cord.

F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.

1. Type: Braided nylon cord.

G. Valance: Manufacturer's standard.

H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.

1. Type: End mounted on wall or overhead.
2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.

I. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.

J. Colors, Textures, Patterns, and Gloss:

1. Slats: White.

2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.3 HORIZONTAL LOUVER BLIND FABRICATION

A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch, plus or minus 1/8 inch.

C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.

D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

F. Color-Coated Finish:

1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, [**locations of connections to building electrical system,**] and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.

1. Locate so exterior slat edges are not closer than 1 inch from interior faces of glass and not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
2. Install mounting and intermediate brackets to prevent deflection of headrails.
3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that horizontal louver blinds are without damage or deterioration at time of Final Acceptance.

C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Final Acceptance.

END OF SECTION 122113

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motor-operated roller shades with single rollers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches long.

D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MOTOR-OPERATED, SINGLE-ROLLER SHADES **(MS-PMC)**

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. MechoShade Systems, Inc.; ElectroShade, Electro/1 Standard Bracket (Basis of Design)
2. Draper Inc.
3. Lutron Shading Solutions

B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: Manufacturer's heavy-duty tubular, enclosed in roller.

a. Electrical Characteristics: 120-V ac.
b. Maximum Total Shade Width: As required to operate roller shades indicated.
c. Maximum Shade Drop: As required to operate roller shades indicated.
d. Maximum Weight Capacity: As required to operate roller shades indicated.

3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:

a. Individual/Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.

b. Color: As selected by Architect from manufacturer's full range.

4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
6. Operating Features:

a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: As standard with manufacturer to suit installation.
2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
3. Shadeband-to-Roller Attachment: Manufacturer's standard method.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.

F. Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shadeband material.
b. Color and Finish: As selected by Architect from manufacturer's full range.

G. Installation Accessories:

1. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

a. Closure-Panel Width: As indicated on Drawings.

2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES **(MS-SMF)**

A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

1. MechoShade Systems, Inc.; ElectroShade, Electro/2 Standard Bracket (Basis of Design)
2. Draper Inc.
3. Lutron Shading Solutions

B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Electric Motor: Manufacturer's heavy-duty tubular, enclosed in roller.
    a. Electrical Characteristics: 120-V ac.
    b. Maximum Total Shade Width: As required to operate roller shades indicated.
    c. Maximum Shade Drop: As required to operate roller shades indicated.
    d. Maximum Weight Capacity: As required to operate roller shades indicated.
3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
    a. Individual/Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
    b. Color: As selected by Architect from manufacturer's full range.
4. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.
5. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
6. Operating Features:
    a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
    1. Roller Drive-End Location: As standard with manufacturer to suit installation.
    2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
    3. Shadeband-to-Roller Attachment: Manufacturer's standard method.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.

F. Shadebands:
    1. Shadeband Material: Light-filtering fabric.
    2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
        a. Type: Enclosed in sealed pocket of shadeband material.
        b. Color and Finish: As selected by Architect from manufacturer's full range.

G. Installation Accessories:
    1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
        a. Shape: L-shaped.
        b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 3 inches.
    2. Endcap Covers: To cover exposed endcaps.

3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Roller shade manufacturer.
2. Type: PVC-coated polyester.
3. Orientation on Shadeband: Railroaded.
4. Openness Factor:

a. Events and Classrooms: 1 percent.
b. Other Areas: 3 percent.

5. Color: As selected by Architect from manufacturer's full range.

2.5 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

C. Roller Shade Locations: At exterior windows.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Final Acceptance.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Final Acceptance.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413

SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad countertops.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plastic-laminate-clad countertops.

1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
2. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.

C. Samples: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Fabricator shall have a minimum of five years continuous experience in performing work of similar quality and scope.

B. Installer Qualifications: Fabricator of products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.

B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.

B. Grade: Custom.

C. High-Pressure Decorative Laminate **(PLAM-2)**: NEMA LD 3, Grade HGS.

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

a. Formica Corporation
b. Pionite; a Panolam Industries International, Inc. brand
c. Nevamar
d. Wilsonart

D. Edge Treatment: 3.0-mm PVC edging.

E. Core Material: Particleboard or MDF.

F. Core Material at Sinks: Particleboard made with exterior glue or MDF made with exterior glue.

G. Core Thickness: 3/4 inch.

H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.

1. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
2. Particleboard: ANSI A208.1, Grade M-2 or Grade M-2-Exterior Glue.

2.3 ACCESSORIES

A. Grommets for Cable Passage through Countertops: 2-inch OD, molded-plastic grommets and matching plastic cap with slot for wire passage; color as selected by Architect.

2.4 MISCELLANEOUS MATERIALS

A. Adhesive for Bonding Plastic Laminate: Manufacturer's standard.

B. Installation Adhesive: Manufacturer's standard.

2.5 FABRICATION

A. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.

B. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.
2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semiexposed surfaces.

C. Protection: Provide suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Final Acceptance.

END OF SECTION 123623.13

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops and window sills.
2. Solid surface material backsplashes.

1.2 ACTION SUBMITTALS

A. Product Data: For solid surface materials.

B. Shop Drawings: Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

C. Samples: For each type of material exposed to view.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface materials to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate solid surfaces similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of solid surface.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.

1. Build mockup of typical countertop as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.6 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops and window sills by field measurements before fabrication is complete.

1.7 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS **(SSM-1, SSM-2)**

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

a. E. I. du Pont de Nemours and Company; Corian (Basis of Design)
b. Aristech Surfaces; Avonite
c. Hanwha Surfaces.
d. LG Hausys; Hi-Macs
e. Samsung Chemical USA, Inc.
f. Wilsonart

2. Type: Provide Standard type unless Special Purpose type is indicated.
3. Colors and Patterns: As indicated on Materials and Finish Schedule.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Custom.

B. Configuration:

1. Front: Straight, slightly eased at top.
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.

C. Countertops and Backsplashes: 3/4-inch- thick, solid surface material.

D. Window Sills: 1/2-inch- thick, solid surface material.

E. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints: Fabricate straight countertops and window sills, eight feet or less, without joints.

G. Joints: Fabricate countertops and window sills in sections for joining in field, with joints at locations as approved by Architect.

1. Joint Locations: Not within 18 inches of a sink and not where a countertop section less than 36 inches long would result, unless unavoidable.
2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.

H. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

   a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.

2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive solid surface material and conditions under which solid surface will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install solid surfacing materials level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Secure window sills to substrate with adhesive according to solid surface material manufacturer's written instructions.

D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 124813 - ENTRANCE WALK-OFF CARPET

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carpet-tile entrance mats.

1.2 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 floor mats.

B. Shop Drawings:

1. Divisions between mat sections.
2. Perimeter floor moldings.

C. Samples: Floor mat, in manufacturer's standard sizes.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For floor mats to include in maintenance manuals.

1.4 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet-Tile Entrance Mats: Full-size tile units equal to 5 percent of amount installed, but no fewer than 10 units.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS, GENERAL

A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities.

2.2 CARPET-TILE ENTRANCE MATS

A. Carpet-Type Tiles **(WOM)**: Nylon carpet bonded to premium backing to form mats of manufacturer's standard thickness with nonraveling edges.

1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:

a. Interface LLC; Step Repeat Series. (Basis-of-Design).

b. Mannington Mills, Inc.
c. Milliken & Co.

2. Construction: Tufted textured loop pile.
3. Fiber: 100% Recycled Content Nylon.
4. Dye Method: Solution dyed.
5. Tufted Yarn Weight: 26 oz/sq. yd.
6. Pile Height: 0.19 inch.
7. Density: 6,686 oz./cu. yd.
8. Tile Size: Nominal 20 by 20 inches.
9. Colors: As indicated on Finish Legend on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, sizes, and other conditions affecting installation of floor mats.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.

B. Install units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.

3.3 PROTECTION

A. Protect mats until construction traffic has ended and Project is at Final Acceptance.

END OF SECTION 124813

SECTION 210000 - GENERAL FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Specification requirements defined in Division 22 of this specification apply to and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 21. Contractor shall provide the requirements specified in Division 22 to obtain complete systems, tested, adjusted, and ready for operation.

B. Contractor shall comply with all requirements contained in NC State Construction Office “2020 WATER BASED FIRE PROTECTION SYSTEMS GUIDELINES AND POLICIES”.

1.2 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.

B. Refer to Division 07 for firestopping requirements.

PART 2 - PRODUCTS

2.1 ATTIC STOCK

A. Sprinklers

1. Base Bid: Provide sprinkler cabinet complete with 3-5 of spare heads of each type and temperature rating, vacuum wrapped, and special wrenches in accordance with NFPA 13.

PART 3 - EXECUTION

3.1 Not Applicable to this Section.

END OF SECTION 210000

SECTION 211318 - FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies materials, methods, and equipment to be used for the installation of sprinkler systems and related piping within the library only.

B. As Shown on drawings, systems shall consist of:

1. Automatic fire protection which consists of:

   a. Automatic wet sprinkler system.
   b. Automatic preaction sprinkler system.
   c. Manual wet standpipe system.

C. Each wet pipe sprinkler zone shall begin with:

1. Zone control valve with tamper switch.
2. Check valve
3. Pressure relief valve
4. Flow switch
5. Inspectors test and drain valve

D. This Section specifies design criteria for fire protection system for this building. Sprinkler zones and main piping layouts of the fire protection system have been established, as it relates to architecture, structure and mechanical/electrical systems in this building. Other layouts shall be produced by Contractor, based on these layouts.

1.2 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 RELATED WORK

A. Section 220000 – General Plumbing Requirements.

B. Section 220529 - Plumbing Supporting Devices.

C. Section 220553 – Plumbing Systems Identification.

D. Section 220584 – Plumbing Systems Firestopping.

E. Section 283116 – Multiplexed Fire Detection System.

1.4 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

1.5 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA 13, Installation of Sprinkler Systems, 2013 Edition.
2. NFPA 14, Installation of Standpipe and Hose Systems, 2013 Edition
3. NFPA 20, Standard for Installation of Stationary Fire Pumps, 2013 Edition
4. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances, 2013 Edition
5. NFPA 72, National Fire Alarm and Signaling Code, 2013 Edition
6. NFPA 101, Life Safety Code, 2015 Edition
7. North Carolina Building Code, 2018 Edition
8. North Carolina Fire Code, 2018 Edition
9. Underwriters Laboratories (UL) Fire Protection Equipment Directory
10. North Carolina State Construction Office Design Guidelines, March 2020
11. University of North Carolina Wilmington – Design and construction Guidelines

B. Contractor Responsibilities:

1. Contractor shall provide detailed working shop drawings, hydraulic calculations, and product data. The drawings shall be based on the system as designed by the Specifying Engineer and submitted to the Specifying Engineer for review. Shop drawings shall include and be in accordance with working plan requirements of chapter 22 of NFPA 13. Product data shall include and identify all material, equipment, and accessory selections to be installed. A copy of the water flow test shall be included. The hydraulic calculations and shop drawings shall be signed by the fire sprinkler designer and include the NC Fire Sprinkler Contractor (FS) license number. The construction documents are a performance design. The fire sprinkler contractor, as the designer and contractor, shall provide all necessary materials and labor for a system fully compliant with all applicable NFPA requirements and the construction documents. Any discrepancies shall be brought to the attention of the specifying engineer (PE).
2. The Specifying Engineer (PE) has primary responsibility for review and approval of fire suppression system shop drawings and hydraulic calculations. Specifying Engineer review shall determine compliance with applicable Codes and standards and the project contract documents. After completing this review, the Specifying Engineer sends and uploads the cover letter w/ engineers comments, drawings, hydraulic calculations, product data and seismic calculations to Interscope for electronic review.
3. Once all comments are resolved and approved by NCSCO, an approval letter releasing this part of the project to enter into construction will be sent to the Specifying Engineer. No other reviews are required after the receipt of this approval letter.
4. Contractor shall be licensed in the State of North Carolina for installation of fire protection systems.
5. Contractor Installation Program:

   a. Planning, calculations, layout, and installation shall be performed by licensed persons employed by Sprinkler Contractor. Certified Sprinkler Designer (NICET level III) or licensed Professional Engineer for planning and calculations, and journeyman sprinkler fitters for installation foreman and supervisory personnel. Field installation shall be constantly supervised by competent, experienced journeyman fitter(s).
   b. Contractor shall be licensed in the State of North Carolina for installation of sprinkler fire protection systems.

C. Electrical Coordination

1. All relays, wire, conduit, pushbuttons, pilot lights, and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 contractors, except as specifically noted elsewhere in this specification.
2. Should any change in electrical equipment size, horsepower rating or means of control be made to any motor or other electrical equipment after contracts are awarded, sprinkler contractor is to immediately notify Division 26 and Division 28 contractors of this change and pay any costs due to this change.

3. Division 26 contractors shall provide all power wiring and sprinkler contractor shall be responsible for providing all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
4. Sprinkler contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 contractors.
5. Furnish wiring diagrams to Division 26 and Division 28 contractors for equipment and devices furnished by sprinkler contractor which have been indicated to be wired by Division 26 and Division 28 contractors.

1.6 SUBMITTALS

A. Shop drawings on items specified herein.

1. Pipe and Fittings
2. Valves
3. Tamper Switches
4. Flow Switches
5. Pressure Switches
6. Preaction Valve and Accessories
7. Pressure relief valves
8. Exterior Waterflow Alarm
9. Sprinkler Heads
10. Sprinkler Head Cabinet
11. Riser Check Valve
12. Hangers
13. Pressure Gauges
14. Fire Department Valves (FDV)
15. Fire Pump and Accessories
16. Jockey Pump and Accessories
17. Fire Pump Test Connection
18. Fire Pump Controller with Automatic Transfer Switch
19. Jockey Pump Controller
20. Reduced Pressure Detector assemblies
21. Layout Drawings
22. Hydraulic Calculations

B. Material submittals shall include items listed in product section and additional items necessary to provide complete installation. Where more than one item appears on manufacturer’s catalog sheet, item or items to be used shall be indicated by red marking or arrow.

C. Include items listed in product section and additional items required to provide complete installation.

D. Prior to installation or fabrication of the system components, submit layout drawings, equipment and hydraulic calculation submittals to Engineer of Record.

E. Review of shop drawings does not relieve Contractor from coordinating the installation of work with all other trades, or from compliance with applicable codes and standards.

F. Indicate by red marking or arrow, items to be used where more than 1 item appears on manufacturer's catalog sheet.

G. The specifying Engineer (PE) has primary responsibility for review and approval of fire suppression system shop drawings and hydraulic calculations. Specifying Engineer review shall determine compliance with applicable codes and standards and the project contract documentation.

H. At completion of acceptance tests:

1. Send copy of test log to Engineer
2. Send copy of Contractor's Material and Test Certificates to:

   a. Engineer
   b. Owner

3. Provide Owner with following:

   a. Manufacturer's literature and instructions describing operation and maintenance of equipment and devices installed.
   b. Typewritten chart with identification and location of all access panels serving equipment and valves. Incorporate into O&M manual.
   c. Typewritten valve schedule indicating valve number, fixture/equipment or areas served by each numbered valve. Incorporate into O&M manual.
   d. All tagged valves shall be identified on a set of as-built drawings and provided inside of 3" PVC pipe with removable caps. Locate drawings in Sprinkler Riser 1227 and mount horizontally on wall. PVC pipe shall be stenciled with "SPRINKLER DRAWINGS".
   e. Current copy of NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment. Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

B. Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of same manufacturer.

C. Outside of piping must be cleaned and capped after fabrication. Outside of pipe shall be free of oils so it can be painted without excessive cleaning or preparation.

D. Approval Guides:

1. Unless otherwise indicated, products shall be listed in the latest publication of the UL Fire Protection Equipment Directory for service intended.

2.2 PIPE

A. Above Ground:

1. Carbon Steel, 2" and smaller:

   a. Pipe: Carbon steel pipe, Schedule 40, American Society for Testing of Materials (ASTM) A795, A53, or A135
   b. Fittings:

      1) Malleable iron, threaded, Class 125, 175 psi Cold Water Pressure (CWP) rating, ANSI B16.3
      2) Cast iron, threaded, Class 125, 175 psi CWP rating, ANSI B16.4
      3) Cast iron, flanged, Class 125, 175 psi CWP rating, ANSI B16.1
      4) Carbon steel butt weld, ASTM A234 Grade WPB/American Society of Mechanical Engineers (ASME) B16.9, standard weight, seamless

5) Ductile iron or malleable iron, grooved for mechanical coupling, 175 psi CWP rating, malleable iron conforming to ASTM A47. Fitting, gasket, and coupling shall be furnished by same manufacturer.

c. Joints:

1) Threaded, tapered pipe threads, ANSI B1.20.1
2) Flanged, cast iron, 175 psi CWP rating, ANSI B16.1, square head machine bolts with semi-finished hexagon nuts, ASTM A183, neoprene gasket
3) Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.

2. Carbon Steel, larger than 2”:

a. Pipe: Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53, or A135
b. Fittings:

1) Carbon steel butt weld, ASTM A234 Grade WPB/ASME B16.9, Schedule 10, seamless.
2) Ductile iron or malleable iron, roll grooved for mechanical coupling, 175 psi CWP rating, malleable iron conforming to ASTM A47. Fitting, gasket, and coupling shall be furnished by same manufacturer.
3) Acceptable manufacturers: Anvil Gruvlok, Tyco Grinnell, Victaulic, Viking, or equal

c. Joints:

1) Welded, welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.
2) Mechanical:

a) Grooved couplings shall be same manufacturer as used for grooved fittings.
b) Flexible mechanical, malleable iron, ASTM A47, equal to Victaulic, Style 75
c) Rigid mechanical, ASTM A-536, equal to Victaulic, Style 009N
d) Wet systems gasket: Grade E EPDM gasket per UL 157 and UL 213
e) Dry systems gasket: Victaulic “FlushSeal” or equal
f) Rigid or zero flex type couplings shall be provided when operating pressures cause piping to move out of place or sway on hangers. Flexible couplings may be used where pipe is braced or clamped into rigid position.

3. Provide metal pipe’s exposed threads with corrosion inhibitive paint, equal to Rust-Oleum.
4. Provide pipe identification system with flow directional arrows on fire protection pipe. For additional information about pipe identification, refer to Section 220553 – Plumbing Systems Identification.
5. Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) are not allowed on either new or existing sprinkler systems.
6. Adjustable drop nipples are not allowed on either new or existing sprinkler systems.
7. Expansion joints:

a. Provide AnvilStar Tri-Flex Loop, MetraFlex FireLoop, or swing joints with flexible grooved couplings, pipe nipples, and grooved elbows installed per manufacturer’s installation instructions.
b. Refer to structural drawings for location of expansion joints.

8. Shop welded joints.

a. Welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.

2.3 VALVES

A. Acceptable Manufacturers: Central, Kennedy, Nibco, Milwaukee, Mueller, Reliable, AGF, Tyco, Victaulic, or Viking, model equal to number listed. Note, not all manufacturers will have all valves.

B. All valves shall be UL Listed or FM Approved for application only if required by NFPA 13 or NFPA 14.

C. Gate Valve: Outside screw and yoke (OS&Y), bronze body and trim or cast-iron body bronze mounted and rated for 175 psi non-shock cold water working pressure.

D. Butterfly Valve:

1. Indicating type: 175 psi WOG.
2. Non-indicating type: 175 psi WOG.

E. Check Valve (Anti-Water-Hammer type)

1. Acceptable manufacturers: Reliable, Tyco Fire Products, Victaulic, Viking, or equal
2. Ductile iron conforming to ASTM A536, Grade 65-45-12, rust inhibiting coating, sizes 2” to 5” consisting of stainless steel clapper conforming to ASTM A-167 and for sizes 6” to 8” consisting of ductile iron clapper conforming to ASTM A-536. Equal to Gruvlok Series 78FP.

F. Test and Drain Valves:

1. Threaded bronze globe type with composition disc, 175 psi WOG, for piping assemblies built on site.
2. Combined test and drain valve assembly: Equal to AGF TESTanDRAIN, Victaulic, Style 720, TestMaster II.

G. Drain Valves:

1. Screw-in bonnet bronze globe valves rated to 175-psi non-shock cold water working pressure.
2. Low point drain valves shall have, in addition, 3/4" brass nipple with 3/4" male hose threads and cap.

H. Provide identification sign (enamel on metal) to valves in accordance with NFPA 13, NFPA 14 and Section 220553 – Plumbing Systems Identification.

2.4 PREACTION VALVE AND ACCESSORIES

A. Acceptable manufacturers: Reliable, Tyco Fire Products, Viking

B. Preaction system shall be double interlocked, supervised system.

C. Piping system shall be pneumatically pressurized for supervisory purposes.

D. Valve shall be self-closing design and will not require disassembly for resetting.

E. Each system shall include:

1. Preaction valve trim
2. Pressure operated relief valve
3. Alarm pressure switch
4. Supply control valve
5. Soft seat check valve
6. Nitrogen supervisory pressure monitor
7. Nitrogen supply control valve
8. Release solenoid valve

9. Nitrogen generator
10. Emergency release
11. Microprocessor-Controlled Release Control Panel with compatible Fire Detection System
    a. Acceptable Manufacturers: Notifier
12. Cross zoned w/ photoelectric smoke detectors and fixed temperature heat detectors.

F. Preaction Control Panel:

1. Control panel shall communicate and be coordinated with the main Fire Alarm System.
2. Contacts shall be available so that the main Fire Alarm Control Panel can monitor the preaction system releasing panel for alarm, trouble, and supervisory signals.
3. Provide additional contacts as needed for additional auxiliary functions.
4. Standby power battery: Minimum battery capacity shall be for 24 h standby mode plus 5 minutes alarm mode. Battery derating factor shall be 1.2.
5. Shall include automatic battery charger

G. Provide detection system to operate preaction sprinkler system. Detection system shall be installed per Section 28 3116 – Multiplexed Fire Detection and Alarm Systems and as indicated on electrical drawings.

H. Provide nitrogen generator:

1. FM Approved nitrogen generator w/ integral air compressor shall have capacity to refill system within 30 minutes
2. Purity and alarm/warning monitors

2.5 RISER CHECK VALVE

A. Acceptable manufacturers: Reliable, Tyco Fire Products, Viking

B. Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal, Tyco Fire Products CV-1F, Viking Model G-1, or equal.

2.6 FIRE DEPARTMENT VALVE (FDV)

A. Acceptable manufacturers: Croker, Elkhart Brass, Potter-Roemer, or equal

B. Fire Department valve shall be 2-1/2" angle valve, polished brass body finish, equal to Potter-Roemer Model 4065. Valve cap for 2-1/2" valve shall be 2-1/2" cap with chain, Potter-Roemer, Model 4625 or equal. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.

2.7 TAMPER SWITCH

A. Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of SPDT (Form C) contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model. Potter Electric Signal Co., OSY series or equal.

B. Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide optional cover tamper kit. Potter Electric Signal Co., PIBV series or equal.

C. Tamper switch shall be UL Listed and capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.

D. Unit shall be compatible with building's fire alarm system.

2.8 WATER FLOW SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, Viking

B. Preferred brand alternate - Potter Electric Signal Co.

C. Flow switch shall be UL listed and/or FM approved, capable of transmitting signal when flow of water equals or exceeds discharge of single head. Unit shall be vane type, with retard chamber and electrical characteristics compatible with fire alarm system. Provide optional cover tamper kit. Potter Electric Signal Co. VS series or equal.

D. Unit shall be compatible with building's fire alarm system.

2.9 WATER FLOW PRESSURE SWITCH

A. Acceptable manufacturers: Potter Electric Signal Co., System Sensor, Viking

B. Preferred brand alternate - Potter Electric Signal Co.

C. Pressure actuated switch to detect a decrease from normal system pressure in preaction sprinkler systems, 300 psi service pressure rating, set to operate at a pressure decrease of 10 psi at 20 psi, 2 sets of SPDT (Form C) contacts rated at 2 Amps at 30 VDC and 10.1 Amps at 125/250 VAC. Provide optional cover tamper kit. Potter Electric Signal Co. PS series or equal.

D. Unit shall be compatible with building's fire alarm system.

2.10 WATER FLOW ALARM BELL

A. Acceptable manufacturers: Cooper Wheelock, Potter Electric Signal Co., or equal

B. Basis of Design:

1. Cooper Wheelock, ASWP series red finish with compatible weatherproof backbox. and UL 464, Audible Signal Appliances. Potter Electric Signal Co., 6" diameter bell with compatible weatherproof backbox.

C. Device shall be compatible with building's fire alarm system.

D. 24V DC power controlled by FAS.

E. Provide approved signage per NFPA 13.

2.11 SPRINKLERS

A. Acceptable manufacturers: Reliable Automatic Sprinkler Co., Tyco, Viking Corporation.

B. Sprinklers shall be UL listed.

C. Automatic heads to have temperature rating suitable for the location. Provide the following type of sprinkler head where indicated on drawings.

1. In unfinished areas such as mechanical spaces, equipment rooms, etc.:
   a. Quick response, brass upright or brass pendant, 5.6 K-Factor, standard orifice, ordinary temperature class (155°F) with wire sprinkler cage.
2. In Soundstar modules (cloud ceiling):
   a. Semi-recessed pendant, quick response, standard orifice, ordinary temperature class (155°F), chrome plated. Coordinate with architect for exact color.
3. In all other areas with ceiling:
   a. Concealed pendant, quick response, standard orifice, ordinary temperature class (155°F), adjustable sprinkler with cover plate flush with ceiling. Cover plates to match ceiling finish. Cover plate colors shall be coordinated to match with ceiling colors and furnished by the sprinkler manufacturer. Do not paint sprinkler cover plates. White cover plate color shall be RAL 9016 "Traffic White".
4. In areas where ceiling conditions do not permit installation of pendent head or finished area where sidewall head provides better coverage of hazard.
   a. White painted brass sidewall, standard orifice, ordinary temperature class (155°F), 2-piece adjustable escutcheon.

D. Temperature ratings of sprinkler heads shall be verified if installed close to heat sources or in special hazard areas. Sprinklers installed close to heat sources shall be rated 50°F higher than the expected temperature of the adjacent heat source.

E. Sprinkler heads shall be provided with plastic shipping cups.

F. Provide wire sprinkler guards for all sprinklers lower than eight feet above finished floor, in all electric rooms, exterior access areas, mechanical/equipment rooms and in all telecom rooms.

G. Provide sprinkler under obstructions more than 4 ft. wide that prevent sprinkler discharge from reaching hazard.

H. Sprinkler Cabinets:
   1. Complete with required number of spare heads of each type and temperature rating, vacuum wrapped, and special wrenches in accordance with NFPA 13.
   2. Provide multiple cabinets to meet this requirement.
   3. Coordinate cabinet locations with Owner's representative.

2.12 BALL DRIP

A. Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products, or equal

B. Exterior discharge must be coordinated with Architect and Owner.

2.13 ACCESSORIES

A. Acceptable Manufacturers: Elkhart Brass, Potter-Roemer, Harrington, Badger-Powhatan, Metal Cabinet Company, Fire End and Croker Corp., and American Fire Hose - Cabinet Co., equal to product listed.

B. Accessories shall be UL listed or FM approved.

2.14 FIRE PUMP

A. Submitted under the Enabling Package A

2.15 CONTROL EQUIPMENT FOR ELECTRIC DRIVE

A. Submitted under the Enabling Package A

2.16 JOCKEY PUMP (JP)

A. Acceptable manufacturers: A-C Fire Pump, Aurora Pump, Patterson Pump, Peerless Pump

B. Jockey pump shall be:

1. Same manufacturer and electrical requirements as main fire pump.
2. Centrifugal jockey pump rated for 5 gpm at 65 psig.

C. Pump casing shall be pressure rated to handle system pressure.

D. Pump and motor shall be integrally mounted on common steel baseplate.

2.17 JOCKEY PUMP CONTROLLER

A. Acceptable manufacturers: Eaton/Cutler-Hammer, Firetrol, Metron

B. Preferred brand alternate - Eaton/Cutler-Hammer

C. Jockey pump controller shall be same manufacturer as main fire pump controller.

D. Jockey pump controller:

1. Wall mounted, NEMA Type 2 control cabinet
2. Maintain automatic sprinkler system at 5-10 psi above fire pump starting pressure.
3. Mercury-free pressure switch with independent adjustment
4. Multiple position control switch
5. 3-pole disconnect switch
6. Starter

2.18 Reduced Pressure Detector Assemblies (RPDA)

A. Manufacturers: Zurn/Wilkins, Watts, Cla-Val or equal to model listed

B. Ductile iron body, epoxy coated, resilient check valve seats, full-port OS&Y gate valves, Y-pattern strainer with bronze body and stainless-steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1047 and NSF/ANSI 61, equal to Zurn/Wilkins 375ADA

2.19 HANGERS

A. Hangers Acceptable manufacturers: Afcon, Anvil, B-Line, Tolco, or equal

B. Concrete expansion hangers, when provided, are to be Hilti, Phillips, Powers, or equal

C. Hanger rods shall comply with Manufacturer Standardization Society (MSS) standards and manufacturer's published load rating.

D. Provide hanger rod, hanger rod attachments, bolts, U-bolts, nuts, studs and washers with electroplated zinc coating or with hot-dipped galvanized finish.

E. Riser clamps shall be electroplated zinc coated or have a hot-dipped galvanized finish and shall not protrude more than 2" beyond edge of hole. Provide Anvil Fig. 261 or equal.

2.20 PRESSURE GAUGES

A. Acceptable manufacturers: Ashcroft, Potter-Roemer, Viking, or equal

B. Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window, and provided with connection not smaller than 1/4" NPT.

C. Include ball valve with provisions for draining on each pressure gauge.

2.21 DIELECTRIC FITTINGS

A. Insulating nipple, metal casing, inert thermoplastic lining, and Clearflow dielectric fitting by Perfection Corporation.

B. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets, and pressure rating of not less than 175 psig at 180 degrees. Watts Regulator Company, Lochinvar, Wilkins or Epco Sales, Inc.

PART 3 - EXECUTION

3.1 DESIGN CRITERIA

A. Flow Test:

1. Refer to sheet FP000 for flow test information.

B. This flow test data will be used as basis for contract documents.

C. Sprinkler Contractor, prior to preparation of installation drawings and hydraulic design calculations, shall conduct a hydrant flow test and this flow test data will be used as basis for design calculations.

D. The hydraulically calculated system shall be designed to a minimum of the recorded flow test static pressure less 10 psi, residual pressure less 10 psi and residual flow less 10%.

E. Basis of Design:

1. Office areas and general building spaces shall be hydraulically designed to provide minimum density of 0.10 gpm per sq ft over most hydraulically remote 1500 sq ft. Heads shall be rated at 155°F and have maximum spacing of 225 sq ft per head.
2. Equipment rooms, storage rooms, and laboratory areas shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft over most hydraulically remote 1500 sq ft. Heads shall be rated at 155°F and have maximum spacing of 130 sq ft per head.
3. Calculated areas may not be reduced with use of quick response sprinkler heads.

F. Hose Streams:

1. Add 250 gpm outside hose stream to sprinkler hydraulic calculations.

G. Sprinkler System Layout and Installation Drawings:

1. Contractor shall review design drawings and specifications, and shall produce calculations, product data sheets, and installation drawings.
2. Water velocity throughout entire system shall not exceed 25 fps and shall not exceed 18 fps at vane type flow switch locations.
3. Contractor shall be held to have examined "Reflected Ceiling" drawings as well as building plans. Contractor shall coordinate routing of piping with other trades and Architect. Sprinkler fabrication drawings shall show reflected ceiling plan and items associated with ceiling.
4. Submit stamped and sealed installation drawings, calculations, and product data sheets for coordination review to Engineer (see submittals).
5. Contractor shall coordinate routing of piping with other trades and Architect.
6. Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.

3.2 INSPECTION

A. Investigate site conditions, verify utility locations and elevations before start of construction. Discrepancies will be checked with Architect/Engineer before proceeding with construction.

3.3 INSTALLATION

A. Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.

B. Install hydraulically designed standpipe system and associated accessories according to requirements of NFPA 14 and as shown on drawings.

C. Install pipe, fittings, couplings, and valves according to requirements of manufacturer.

D. Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.

E. Pipe and fittings shall be of corresponding materials when assembled.

F. Above Ground Pipe:

1. Provide pipe identification system with flow directional arrows on fire protection pipe in accordance with manufacturer’s installation instructions. For additional information, refer to Section 220553 – Plumbing Systems Identification.
2. Coat exposed threads with corrosion inhibitive paint, equal to Rust-Oleum. Apply paint per manufacturer’s instructions.

G. Provide valved flushing connection at end of cross-mains on each floor. Minimum size of flushing connection shall be 2”. Flushing connections must be accessible and not installed above duct work, cable trays, conduit racks, electrical panels, sheet rock ceilings, or abutted to walls.

H. Provide test connection for each flow switch.

I. Drain line detailed adjacent to standpipe/sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone to termination point shown on drawings.

J. Provide auxiliary drains at low points of systems per requirements of NFPA 13.

K. Identify valve with brass tag denoting which flow switch is being tested when test valves are located remote from flow switch.

L. Clamp-on or saddle type fittings are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.

M. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic, Style 750, are allowed.

N. Feed sprinkler heads with swing joint or return bend arrangement bend in accordance with NC - SCO requirements for all locations.

O. Sprinklers are required to be installed in the center of ceiling tiles.

P. Provide minimum 1” outlets with sprigs or drops for sprinklers located in shelled spaces.

Q. Install tamper switch on each shutoff valve.

R. All control valve and floor control assembly shall be accessible from the floor level and shall not be more than 6’ above the floor.

S. All main drains shall discharge to exterior.

T. Install sprinkler heads as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional heads beneath obstruction.

U. Make joints of threaded pipe by cutting pipe square and reaming inside.

V. Use joint compound sparingly.

W. Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer’s gasket lubricant sparingly.

X. Pipe grooving shall be per coupling manufacturer’s instructions.

Y. Welded joints shall be made in fabrication shop. No welding allowed at project site.

Z. Hangers, Bracing, and Restraint of System Piping:

1. Provide hangers and associated parts to support piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet requirements of NFPA 13, Section 220529 – Plumbing Supporting Devices and manufacturer’s installation instructions.
2. Select and size building attachments per Manufacturer Standardization Society (MSS) standards and manufacturer’s published load rating.
3. Coordinate hanger support installation to group piping of all trades.
4. Hang pipe from building members using either concrete inserts for concrete construction or beam clamps for steel construction. Installation shall comply with manufacturer’s installation instructions. Expansion type inserts may be used for branch piping.
5. Suspend hangers by means of electroplated zinc or hot-dipped galvanized finish hanger rods. Perforated band iron and flat wire straps (strap iron) are not allowed.

6. Mains parallel to joists shall not be supported from a single joist. Mains parallel to joists shall be supported by trapeze hanger and be positioned equally between two joists. Trapeze hangers shall be positioned to load joists at panel points only.
7. Support pipe from top flange of joists and beams.
8. Where joists are used, locations of pipe supports shall be approved by the structural engineer prior to installation.
9. Do not support equipment or piping from metal roof deck.

AA. Install pressure gauges as required in manufacturer's installation instructions, and as required per NFPA standards.

BB. Generally, install capped tees in lieu of couplings for future connections where shown on engineering drawings.

CC. Remove sprinkler head plastic shipping cups only after final ceiling installation.

3.4 FIRE PUMP INSTALLATION

A. Submitted under the Enabling Package A

3.5 CLEANING

A. Flush entire sprinkler system to purge cutting oil, debris, and metal fines.

B. Ensure underground feed pipe has been flushed per NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances, to clear out construction debris, prior to connecting aboveground fire protection system to it.

C. Clean systems after installation is complete.

D. Clean piping both internally and externally to remove dirt, plaster dust, or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition. Replacement of heavily soiled and deteriorated materials shall be done at the Contractor's expense.

E. Clean equipment as recommended by manufacturers. Thoroughly clean equipment of stains, paint spots, dirt, dust, and any other foreign materials. Remove temporary labels not used for instruction or operation.

3.6 TESTING

A. Refer to testing paragraph of Section 220000 - General Plumbing Requirements.

B. Coordinate fire pump test with Division 26 and Division 28 contractors.

C. Perform all NFPA required acceptance tests.

D. Test sprinkler system as entire system or partial system. System shall be hydrostatically tested at not less than 200 psig for 2 h. No leakage allowed. Replace defective joints with new materials. No caulking of defective joints allowed. Re-test system after defective joints are replaced, until satisfactory results are obtained.

E. Hydrostatically test piping between the exterior fire department connection (FDC) and the check valve in the fire department inlet pipe in the same manner as the balance of the system.

F. Pipe shall not be concealed until satisfactorily pressure tested.

G. Conduct main drain test. Record static pressure and residual pressure per NFPA 13.

H. Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.

I. Log of tests shall be kept at job site and shall identify:

1. Who performed the test
2. Time of test
3. Date of test
4. Section of system tested
5. Results of test
6. Completed Contractor's Material and Test Certification form(s) from NFPA 13 and NFPA 14.

J. Operate flow and pressure switches to test that signals are transmitted to Fire Alarm Control Panel.

K. Include test for tamper switches.

3.7 FIRE PUMP TESTING

A. Submitted under the Enabling Package A

END OF SECTION 211318

SECTION 220000 - GENERAL PLUMBING 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 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems, tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 22 contract documents shall mean "furnish and install". There is no owner furnished equipment.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations, or adjustments necessary to complete work or to avoid interference with other trades.

E. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

F. Where architectural features govern location of work, refer to architectural drawings.

G. Refer to structural drawings to familiarize with structural member sizes, framing, opening sizes, shear walls and braced frame details and miscellaneous details which may impact the work.

H. Contractor may install additional piping, fittings, and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

1.3 RELATED WORK

A. Utility Services:

1. Determine utility connection requirements and include in base bid all costs to Owner for utility service.
2. Include costs for temporary service, temporary routing of piping or any other requirements of a temporary nature associated with utility service.
3. All underground nonmetallic piping shall have tracer wire.
4. All underground piping shall have warning tape installed above it, 6” below finish grade.

B. Commissioning

1. Refer to Division 1 – General Commissioning Requirements and Functional Testing Requirements.
2. Selected systems and equipment will be commissioned as part of the project requirements. This contractor shall support commissioning as defined elsewhere in these specifications.

C. Temporary Services:

1. Refer to Division 1.

D. Continuity of Service:

1. No service shall be interrupted or changed without permission from Engineer and Owner. Obtain written permission before any work is started.
2. When interruption of services is required, Contractor shall contact Owner and Designer in writing at least 10 working days prior to requested shutdown date. Request for utility interruption shall include proposed date(s) of shutdown, duration of shutdown, utility to be disrupted, and description of work. UNCW Personnel shall perform disruption of utility service. Coordinate with UNCW for proper lockout/tagout procedures and notification to proceed with work.
3. In the event that the Contractor damages a utility line, the responsible Contractor shall immediately contact the Owner and Designer, and the Owner of the utility to report the incident. The responsible Contractor shall immediately repair the damaged utility to the satisfaction of the Owner of the utility.

E. Concrete Work:

1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of mechanical equipment.
4. This work shall also include, but is not limited to, providing all housekeeping pads not shown on the structural plans for equipment within Div 21 and Div 22.

F. Painting:

1. Refer to Section 220553 – Plumbing Systems Identification for additional requirements.
2. Furnish equipment with factory applied prime finish unless otherwise specified.
3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
4. Furnish one can of touch up paint for each factory finish which will be final finished surface of product.

G. Firestopping Penetrations:

1. Refer to Division 07 for firestopping requirements.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1. AGA American Gas Association
2. ANSI American National Standards Institute
3. ASPE American Society of Plumbing Engineers
4. ASSE American Society of Sanitary Engineering
5. AWWA American Water Works Association
6. ASME American Society of Mechanical Engineers
7. ASTM American Society for Testing and Materials
8. CISPI Cast Iron Soil Pipe Institute

9.	FM	Factory Mutual Engineering
10.	FS	Federal Specifications
11.	IEEE	Institute of Electrical and Electronics Engineers
12.	MCA	Mechanical Contractors Association
13.	MSS	Manufacturers Standardization Society
14.	NEC	National Electrical Code
15.	NEMA	National Electrical Manufacturers Association
16.	NFPA	National Fire Protection Association
17.	NIST	National Institute of Standards & Technology
18.	NSF	National Sanitation Foundation
19.	PDI	Plumbing and Drainage Institute
20.	UL	Underwriters Laboratories, Inc.

B. In addition, all work shall also conform to the latest edition of the North Carolina State Building Codes including:

1. Building Code
2. Plumbing Code
3. Fuel Gas Code
4. Energy Conservation Code

1.6 SUBMITTALS

A. Shop Drawings (Product Data):

1. Refer to Division 1 – Submittal Procedures for administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other Miscellaneous Submittals.
2. Note that for satisfying submittal requirements for Division 22, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 1. However, the expression "Shop Drawings" is generally used throughout the specifications.
3. Submit shop drawings for equipment and systems as requested in the respective specification sections. Submittals which are not requested may not be reviewed.
4. Mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product on drawings. Cross off all extraneous data which does not pertain to submitted equipment and circle all applicable options.
5. Contractor shall clearly indicate on submittals any deviations from project specifications. Approval granted on shop drawings shall not relieve the Contractor of their responsibility to construct the work in accordance with the Contract Documents and specifications.
6. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
7. When manufacturer's reference numbers are different from those specified, provide correct cross reference numbers for each item. Submittals shall be clearly marked and noted accordingly.
8. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include all required components.
9. Submittals of electrically powered equipment and devices shall include composite wiring diagrams, motor efficiency and power factor data. Submitted wiring diagrams shall be customized to reflect actual project conditions.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submittals which are not complete, not permanent or not properly checked by Contractor will be returned without review.

12. "Coordination Drawings", shall be prepared to coordinate work among all trades and to facilitate installation of systems. These types of drawings typically include dimensioned piping, ductwork, lighting, raceway, cable tray, and major conduit layouts, equipment locations including connections to piping / ductwork systems and maintenance clearances. Refer to Division 01 Coordination for additional Coordination Drawing requirements.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 for administrative and procedural requirements.
2. Prior to submission of Operations and Maintenance Manuals for review, Contractor shall submit index arranged by specification section showing all major items / test forms, etc to be included in manuals for review.
3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system. Include table of contents in each volume where multiple volumes are submitted.
4. Manuals shall include the following:
   a. Copies of all approved shop drawings. Shop drawings shall include record of Designer's review.
   b. Manufacturer's operating and maintenance instructions. Include parts lists of all items or equipment with component exploded views with part numbers. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
   c. CD ROM's of O&M data with exploded parts lists where available.
   d. Phone numbers and addresses of local parts suppliers and service companies.
   e. Internet/WEB page addresses where applicable.
   f. Wiring diagrams.
   g. Startup and shutdown procedures.
   h. Composite electrical diagrams.
   i. Flow diagrams.
   j. Lubrication instructions.
   k. Factory and field test records. (Refer to Test and Balancing in Part 3 of this Section).
   l. Air and water balance reports.
   m. Piping pressure test reports. Test reports shall include record of Designer's review.
   n. Valve identification charts.
   o. Access panel identification charts.
5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus. Training shall include both classroom sessions and "hands on" sessions.
6. Training shall be completed one month prior to the beneficial occupancy of the building.
7. O&M Manuals and Instructions to Owner shall be provided prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract, and Division 1 – Closeout Procedures for administrative and procedural requirements for Record Documents. Prepare complete set of record drawings in accordance with Division 1.
2. Prepare complete set of markups resulting from actual installed conditions by revising original contract documents as prepared by Engineer. Contractor mark-ups shall be forwarded to Engineer.
3. Provide a matrix that lists each piece of equipment that has a serial number. The matrix is to include the manufacturer, model number, serial number and location in the building.

1.7 JOB CONDITIONS

A. Building Access:

1. Coordinate with Owner and Construction Manager for access to site during construction to allow for admittance of all materials and apparatus.
2. This Contractor shall take all precautions necessary to protect equipment from the weather during the construction period. In general, equipment shall be stored in a protective environment during the construction period. In the event that items will be exposed to the weather, provide temporary covers on equipment and weather resistant covers on openings remaining in building structure. Contractor shall be held responsible for costs associated with any damages resulting from unprotected openings during construction of the project.

B. Electrical Coordination:

1. Provide all motors and all electrically powered or electrically controlled equipment.
2. All relays, actuators, timers, alternators, pressure, vacuum, float, flow, pneumatic-electric, electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, selector switches, remote pushbutton stations, emergency break glass stations, interlocked disconnect switches beyond termination point, and other appurtenances associated equipment under Division 22 shall be furnished, installed, and wired under Division 22. Starters, disconnects, wire, and conduit serving motors or electrical equipment shall be provided by Electrical Contractor, except as specifically noted elsewhere in these specifications. Where starts or other devices are furnished by this Contractor, they shall be installed by this Contractor, coordinated with Electrical Contractor, connected by Electrical Contractor and shall be furnished in accordance with Electrical Sections of the specifications.
3. Motor starters for plumbing equipment shall be furnished and installed under Division 22 unless starter is indicated as part of a motor control center. Motor starters for plumbing equipment provided in motor control centers shall be provided under Division 26. Where starter is provided by this Contractor, power wiring shall be provided by Division 26 Contractor to a termination point consisting of a junction box, trough, or disconnect switch. Under Division 26, line side terminations shall be provided. Wiring from the termination to the mechanical equipment, including final connections, shall be provided under Division 22.
4. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 22.
5. Electrical Contractor's drawings and/or specification show number and horsepower rating of motors furnished by this Contractor, together with their actuating devices. Should any change in size, HP rating or means of control be made to any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this Contractor.
6. Electrical Contractor shall provide power wiring and motor control wiring, as indicated on electrical contract documents, except temperature control wiring, and connect all equipment complete and ready to operate.
7. This Contractor shall be responsible for all wiring associated with equipment under this contract, except wiring which is scheduled to be by others.
8. Wiring done by this contractor shall be in accordance with Division 26 requirements and applicable electrical codes.
9. Furnish wiring diagrams to Electrical Contractor for apparatus indicating external connection and internal controls.
10. All standard manufactured items or custom fabricated assemblies of electrically operated equipment shall be listed and labeled by a nationally recognized testing laboratory, such as Underwriter's Laboratory, Inc. (UL).
11. Unless noted otherwise, all local disconnect switches furnished by this Contractor for equipment with electrical power draw of 0.5 kw and above shall be of the fused type unless fusing is provided in the starter assembly.

C. Cutting and Patching:

1. Refer to Div 1 for procedural requirements for cutting and patching.
2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore all work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide all materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Designer and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening. Coordinate with Designer for approval of all core drilled openings prior to commencing with work.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:

1. Refer to Div 1 for procedural requirements for housekeeping and cleanup.
2. Daily as work progresses and/or as directed by Designer, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc., from site.

1.8 WARRANTY

A. Refer to Division 1 for general warranty requirements.

B. Warrant for one year after acceptance by Owner all equipment, materials, and workmanship to be free from defect per Article 42 of the General Conditions. Additional warranty terms to be provided as outlined in individual specification

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 1 – Product Requirements (Substitution Request Form) for administrative and procedural requirements for handling requests for product substitution. Any request for product substitution shall be made in writing and submitted to Designer at least 10 days prior to Bid Opening. Requests received within 10 days of Bid Opening shall not be allowed.

B. Approval of a substitution by the Designer shall not relieve the Contractor of the original responsibility of compliance with contract intent.

2.2 ESCUTECHEONS

A. Chrome-plated, stamped steel hinged, split-ring escutcheon, with set screw.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall closely coordinate with all other contractors on this project prior to installing any piping, conduit, equipment, etc. It is the Contractor's responsibility to coordinate this work with other contractors. Failing to do so will not relieve this contractor from the responsibility of relocating installed piping, conduit, equipment, etc. to accommodate the work of other contractors if so required and directed by the Designer or Owner.

B. Verify elevations and measurements prior to installation of materials.

C. Store and handle all material in compliance with the manufacturer's recommendations to prevent their deterioration and damage. Store all materials in the original containers or bundles with labels informing about manufacturer, product name, and any potential damages. Materials shall not be stored on floor.

3.2 FLOOR, WALL, AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. Provide during progress of construction all sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form openings, shall be removed prior to installation of permanent materials. Permanent sleeves shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. Sleeves provided for floor penetrations shall extend above top of finished floor by a minimum of one inch.

E. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be closed with 10-gauge galvanized sheet metal, round tube welded longitudinal joint. Provide an additional 6" sleeved opening with temporary cap in each of the two pipe chases at each level for future use.

F. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

G. Submit product data and installation details for all penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.

H. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 07 8400 and as detailed on drawings. Avoid multiple penetrations of common fire barrier opening. When possible, seal each penetration in accordance with project details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

I. Openings for pipe shall be minimum 1" larger in diameter than pipe, or where fire resistant penetrations are required, sized in accordance with recommendations of firestopping systems manufacturer.

J. Openings for insulated piping shall be sized based on outside diameter of insulation when it is specified or detailed to be continuous through opening.

K. Seal non-fire-rated floor penetrations with non-shrink grout or sealant as specified in Division 07 Section "Joint Sealers", as appropriate.

L. Where penetrations occur through exterior walls into building spaces, use steel pipe sleeves with integral water stop. Seal annular space between sleeves and pipe with modular wall and casing seals. Where pipe is insulated, insulation shall be butted against seals on both sides. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

M. In lieu of openings as specified herein, approved pre-manufactured penetration systems may be used, including the sleeve couplings and plug. Opening shall not need additional water proofing or riser clamps.

N. Finish and trim penetrations as shown on details and as specified hereinafter.

O. Provide chrome or nickel-plated escutcheons where piping passes through walls, floors or ceilings and in exposed finished areas. Size escutcheons to fit pipe and pipe covering for finished appearance. Finished areas shall not include mechanical/electrical rooms, etc., unless suspended ceilings are provided.

3.3 EQUIPMENT SHUTOFF VALVES

A. Provide shutoff valves at each piece of equipment connecting to piping system.

3.5 EQUIPMENT ACCESS

A. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocation of piping, equipment or accessories as required to provide access shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other equipment being installed or already in place.

C. Access doors in walls, chases, or above inaccessible ceilings will be provided under Div 8, unless otherwise indicated. Access doors for valves, shock stops, unions or equipment/devices requiring access for servicing, repairs or maintenance located in walls, chases or above inaccessible ceilings, unless otherwise noted or other equipment shall provide access for service, repairs, and/or maintenance. Provide necessary coordination information to include required locations, sizes, and rough-in dimensions. Provide labels at all access doors indicating items at access doors. When practical, components requiring access doors shall be grouped together to limit the amount of access doors.

3.6 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or piping from metal roof decking.

3.7 PLUMBING SYSTEMS IDENTIFICATION

A. Refer to Section 220553 – Plumbing Systems Identification

3.8 EQUIPMENT GUARDS

A. Provide equipment guards over belt driven assemblies, pump shafts, exposed fans and elsewhere as indicated in this specification or required by code.

B. Paint all equipment guards bright yellow.

C. All belt guards, including those factory made, shall be ventilated.

3.9 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and any areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" closed cell elastomeric thermal insulation on lower edges of equipment and supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.10 TEST AND BALANCING

A. Tests for equipment and piping systems shall be performed under this Division in accordance with technical requirements noted.

B. All piping inspections and testing shall be successfully completed and approved before application of covering materials.

C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or material as necessary and repeat inspection and test. Make repairs with new materials. Caulking of holes or threaded joints is not allowed.

D. Certify in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria, test medium and pressure used, duration of test and name and title of person signing test certification document. Results shall be submitted to Engineer within 3 days of test occurrence for review.

E. Maintain copies of certified test results, including record of Engineer's review and those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M manuals.

F. Where specified systems require additional test and balance, include requirements as specified in respective sections.

G. Should the Engineer have any reasonable doubt as to the proper functioning of any equipment installed under this Contract at any time during the guarantee period, the Owner and/or Engineer has the right to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the Owner. If the test indicates a deficiency in equipment capacity or performance, the Contractor shall pay the cost of the test and also remedy deficiencies shown by the test to the full satisfaction of the Engineer and Owner at no additional cost to the Owner.

H. Balance entire new water systems. Adjust control valves and mixing valves to proper working set point and adjust balancing valves for proper distribution of system water.

I. Flushing valves, bleed valves, flow control valves, or other regulating devices in plumbing systems shall be adjusted for proper balancing and flow to fixtures and/or equipment.

J. When other systems require special balancing, include requirements as specified under their respective sections.

3.11 START-UP

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This shall include "Owner-furnished, Contractor-installed" (OFCI) as well as "Contractor-furnished, Contractor-installed" (CFCI) systems and equipment. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures. Contractor shall provide services of technician/mechanic knowledgeable in start-up and check-out of types of systems and equipment on project. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel. Coordinate start-up with Construction Manager, Designer, Commissioning Agent and all trades.

3.12 LUBRICATION

A. Upon completion of work and before turning over to Owner, clean and lubricate bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by manufacturer.

B. Maintain lubrication of all mechanical equipment under his contract until Owner accepts work.

3.13 PIPING SYSTEM PRESSURE TESTS

A. Submit planning report to engineer to demonstrate proper procedures are being followed. Planning report shall contain the following minimum requirements:

1. Written narrative of procedure to be used for each system.
2. Provide list of measuring instruments to be used to conduct test. List shall include measurement range, pressure/temperature limits, date put into service, and date of last calibration.
3. Test report forms for review.
4. Planning report shall be submitted to engineer 30 days prior to testing.

B. Coordinate pressure tests with Engineer and Owner, in writing, at least 7 days in advance of its occurrence and conduct tests in presence of Engineer. Engineer has right to wave requirement for witnessing test. If engineer is not present, conduct test in presence of Construction Manager's representative. Representative shall sign report verifying results. Contractor shall notify engineer of all tests to be performed.

C. Conduct pressure test prior to flushing and cleaning of piping systems.

D. Contractor shall perform preliminary pressure test prior to witnessed record test to verify system will pass record test on first attempt.

E. Conduct hydrostatic (HYDRO) test with test medium of water unless otherwise indicated.

F. If leaks are found, repair with new materials and repeat test.

G. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

H. No systems shall be insulated until it has been successfully tested. Conduct a preliminary pressure test prior to final acceptance test to locate and correct any pipe leaks.

I. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

J. Provide pumps, including fittings for additional openings required for test apparatus, appropriately scaled and calibrated gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been successfully conducted.

K. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system, due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

3.14 CLEANING

A. After installation is complete, Contractor shall clean all systems to “as -new” condition (inside and outside). Clean all equipment as recommended by manufacturer.

B. Clean piping both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition.

C. Contractor shall repair or replace any equipment or surfaces of work which is damaged by this Contractor to the full satisfaction of the Owner and Engineer.

D. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

E. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

F. Contractor shall repair or replace any equipment or surfaces of work which is damaged to the full satisfaction of the Owner and Engineer.

3.15 ATTIC STOCK

A. Alternate No. 50: Plumbing Fixtures

1. Base Bid: No attic stock
2. Alternate Bid: Provide one (1) flush valve per water closet type and one (1) restroom lavatory faucet.

END OF SECTION 220000

SECTION 220529 - PLUMBING SUPPORTING DEVICES

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 DESCRIPTION

A. Provide all supporting devices as specified and as required for proper support of piping, equipment, materials and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment and piping, to prevent excess stress and allow for proper expansion and contraction.

1.3 SUBMITTALS

A. Shop drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:

1. Manufacturer's name
2. Model numbers
3. Materials of construction and load ratings (lbs)
4. Schedule of hangers and support devices with pipe support spacing
5. Insulated pipe supports along with application chart or table
6. Insulation protection saddles and weight bearing insulation table
7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
8. Structural attachments, inserts and concrete anchors
9. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
10. Equipment mounting devices
11. All other appropriate data

1.4 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME Code for Pressure Piping B31.1 and MSS Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

D. Determine maximum deflection using the following equation:

1. $D = \frac{H \text{ or } L}{250}$

2. Where:
3. D = Maximum deflection in Inches
   H = Member height in Inches
   L = Member length in Inches

E. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application. Coat cut edges, welds or any damaged finish with galvanized paint.

F. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Provide copper supports for un-insulated copper pipe. Plastic coated steel supports are acceptable.

G. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.

H. This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 220700 - Plumbing Systems Insulation.

I. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

J. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

K. Unless otherwise indicated, continuous insert channels are not allowed.

L. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

M. Application of concrete inserts and concrete anchors shall be reviewed and approved by Structural Engineer prior to installation.

N. Any proposed weld attachments to building structure shall be reviewed by Structural Engineer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

PART 2 - PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspend or floor support equipment.

2.2 PIPE HANGERS AND SUPPORTS

A. Hangers/supports for copper pipe without insulation shall be either copper plated or PVC coated.

B. For insulated pipe supports, refer to Insulated Pipe Supports in Part 3 of this Section.

C. Clevis and Roller Type Hangers Manufactures: Anvil, Erico, Tolco, PHD, Holdrite, or B-Line equal to Anvil figures as indicated below at each support point.

System	Pipe Size	Clevis	Roller
Ambient Bare Pipes (60°F to 119°F)	2" and smaller	65, 260	---
	2-1/2" and larger	260, 216	---
Cold Pipes with Insulation	2" and smaller	65, 260	---
	2-1/2" and larger	260, 295	---
Hot Pipes with Insulation (120°F and above)	2" and smaller	65, 260	---
	2-1/2" to 6"	---	171, 181

D. Flat Surfaces (Trapeze, Rack Type):

1. Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides as indicated below at each support point.
2. Manufactures: Anvil, Erico, Tolco, PHD, Holdrite, or B-Line equal to Anvil figures as indicated below.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (120°F and above)	2" and smaller	137, 243, 244, AS 1300AS-EG, or KLO-SHURE	---	---
	2-1/2" and larger	---	177, 271, 274, AS 1902-EG	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60° to 119°F)	all sizes	137, AS 004OD-EG Series	---	---
Ambient Bare (Copper) pipes (60° to 119°F)	all sizes	AS 004OD-EG Series		
Cold Pipes with Insulation (33°F to 59°F)	10" and smaller	137, AS 1300AS-EG, or KLO-SHURE	---	---

E. Vertical Pipe Supports:

1. Use clamps, straps, inserts or channels to support pipes on wall surface or concealed in wall cavity as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria.
2. Provide clamps, strut channels, insulated supports, or brackets and inserts equal to manufacturer as indicated below at each support point.

System	Pipe Size	Supports	Clamps, Brackets/Insert	Pre-Insulated Inserts
Hot and Cold Pipes with Insulation	all sizes	Anvil 137, Erico 454	HoldRite 260 series inserts with SB1S bracket, Anvil 262,	Anvil Klo-Sure, K-Flex 360, Pipe Shields A2000, or Pro-Shield
Ambient Bare Steel Pipes (60° to 119°F)	all sizes	Anvil 137, 138-R Erico 454	Anvil 262	---
Ambient Bare (Copper) pipes (60° to 119°F)	all sizes	Anvil CT-138R, Erico 454	HoldRite 260 series inserts with SB1S bracket	---

2.3 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167, constructed of galvanized carbon steel. Select shield to accommodate outer diameter of insulation. Shield length and gauge shall be as follows.

Pipe Size	Length	Gauge
1/4" thru 3"	12"	18
4" thru 6"	18"	16

2.4 WEIGHT BEARING INSULATION INSERTS

A. Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.

B. Minimum length of inserts, shall be 12" or 2" longer than insulation protection shields, whichever is longer. Quantity and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.

C. Hot Pipes (120°F and above):

1. High-density calcium silicate insulation (Type H) similar to Johns Manville Thermo-12 or cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas. Maximum compression strength for load calculation shall be 100 psi.
2. HAMFAB H-Block by ICA Inc. may be used. Maximum compression strength for load calculation shall be 30 psi.

D. Cold Pipes (59°F and below):

1. Cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas, maximum compression strength 100 psi, Koolphen K insulation by Kooltherm Insulation, 5 lb/ft3, maximum compression strength 50 psi, or HAMFAB H-Block by ICA Inc., maximum compression strength 30 psi. H-Block inserts shall be coated with vapor barrier coating similar to CADALAR 670 by SKIRGES Corp.

2.5 PRE-INSULATED PIPE SUPPORTS

A. Manufacturers: Anvil, Value Engineered Products, Shaw Pipe Shields, Pipe Shields Inc, Erico, B-Line or Rilco equal to Shaw Pipe Shields models listed.

B. Insulation shall consist of water-resistant calcium silicate or close cell elastomeric (armaflex) of same thickness as adjoining pipe insulation, thermal conductivity not more than 0.38 at 75°F mean temperature, minimum density of 13 lb/ft3, and compressive strength not less than 100 psi.

C. Structural inserts shall be water-resistant, high-density calcium silicate with minimum density of 32 lb/ft3 and minimum compressive strength of 600 psi. Structural inserts shall be used as recommended by manufacturer to meet load ratings.

D. Use vapor barrier steel jacket around insulation. Insulation jackets shall be galvanized steel conforming to ASTM A-527. Hanger bearing surface shall consist of galvanized sheet metal insulation protection shield or casing.

E. When recommended by manufacturer, use double layer insulation protection shield at support bearing surface. Insulation shall extend 1" beyond insulation protection shield to maintain vapor barrier integrity.

F. Pre-insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes and standards: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

G. Load tests shall be made on both supporting materials and configurations. All tests shall be performed by independent testing laboratory. Results of pertinent tests shall be available on request.

H. Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Shaw Pipe Shields, Inc. unless otherwise indicated.

1. Pipe supported on hangers: Models A2000, A4000, A9000, D3000 and D3200.
2. Pipe supported on flat surfaces: Models A2000, A4000, A6000, A7000, A7200, and A7400.
3. Pipe supported on pipe rolls: Models A4000, A6000, A8000, A8200, and A8400.
4. Pipe supported on slides: Model "B" series.
5. A1000, A3000 or A5000 may be used for hot pipes (120°F and above).

I. Select proper model to conform to pipe service, support style, and support spacing.

J. Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

K. Pipe support spacing shall be in accordance with manufacturer's recommendations, but in no case shall exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

2.6 HANGER RODS

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Maximum Load (lbs.) (Not exceeding 650°F Service Temp.)	Rod Diameter (inches)	Max. Pipe Size With Single Rod
610	3/8	2"
1130	1/2	4"
1818	5/8	5"
2710	3/4	6"
3770	7/8	10"
4960	1"	16"
8000	1-1/4"	18"

2.7 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish.

2.8 ROD ATTACHMENTS

A. Anvil Fig. 290, galvanized finish.

2.9 U-BOLTS

A. Anvil Fig. 137, galvanized finish.

2.10 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 218, 228 and 292.

B. Top Beam Clamps: Anvil Fig. 227.

C. C-Clamps: Anvil Fig. 86, 92 or 93. Provide clamps with retaining clips.

2.11 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.12 RISER CLAMPS

A. Anvil Fig. 261 (MSS Type-8), galvanized finish

B. Anvil Fig. CT-121, copper plated carbon steel, plastic coated in area at pipe contact, for bare copper tubing

C. Proset, HoldRite, or Hilti system, equal to Proset proseal plug and fire-fill for sleeved and cored holes.

2.13 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Anvil Fig. 284, Tolco No. 109 A, B-Line Fig. B3019, Powers Fasteners "Bang-It", Hilti HCI-MD, or MSCO No. MX34.

2.14 CONCRETE ANCHORS

A. Manufacturers: Hilti, Powers Fasteners or Red Head

B. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

C. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

D. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

E. Anchors shall be zinc plated in accordance with ASTM B633.

F. Select anchors with load ratings based on cracked concrete conditions.

2.15 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line, Anvil-Strut Systems, Power-Strut, Superstrut, Kindorf, and Hydra-Zorb.

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 ga.

2.16 PIPE ROOF PENETRATION PROTECTIONS

A. Manufacturers: Roof Products & Systems, ThyCurb or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12” OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless-steel clamp.

2.17 FIXTURE SUPPLY PIPING SUPPORT

A. Galvanized steel or copper stud support bracket, pre-drilled tube support mounting holes, adjustable stud width, HoldRite or equal.

B. UV resistant nylon tube insert support, rated for 0°F through 130°F, HoldRite or equal.

C. Support bracket and tube support to be from same manufacturer

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, or wall brackets. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping shall not be supported by other piping.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Install adequate supports during erection of piping so as not to over stress either piping or equipment to which piping is connected.

H. Refer to Section 220000 - General Plumbing Requirements for requirements of personnel injury protection guards for supporting devices.

I. Hangers and supports for fire protection systems shall conform to NFPA 13. Mains parallel to joists shall not be supported from single joist. Mains parallel to joists shall be supported from trapeze hanger and be positioned equally between 2 joists. Trapeze hangers shall be positioned to load joists at panel points only.

J. Top beam clamps shall be used in lieu of C-clamps when hanging 3" and larger pipe from top chord of roof trusses or top flange of beams.

3.2 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4" and smaller	7'-0"
1-1/2"	9'-0"
2"	10'-0"
2-1/2"	11'-0"
3"	12'-0"
4"	14'-0"

C. Copper Tube (Water, Force Main):

Pipe Size	Max Spacing
1/2” to 1”	6”-0”
1-1/4" and 1-1/2”	8'-0"
2" and 2-1/2”	9'-0"
3” and larger	10’-0”

D. PVC Pipe:

Pipe Size	Max Spacing
All sizes	4’-0”

E. Provide copper tube size riser clamps at base of each floor and at top of every other floor with mid-floor guides for hot water systems.

F. Provide copper tube size riser clamps at base of each floor and top of every 4 floors with mid-floor guides for cold water systems.

G. Support plastic pipe at all changes of direction. Adequate consideration shall be given to piping expansion.

H. Cast Iron Pipe:

1. Support Cast Iron No-Hub pipe as recommended in CISPI Publication "Cast Iron Soil Pipe and Fittings Handbook, Chapter IV - Installation of Cast Iron Soil Pipe and Fittings."
2. Maximum hanger and support spacing for cast iron piping shall be 5 ft for all sizes. Spacing may be increased to 10 ft where 10ft lengths of pipe are installed. Provide minimum of one hanger per pipe section close to joint on barrel, at each pipe fitting, at change of direction and branch connections.

I. Maximum spacing shown above may be restricted by strength of attachment to building structure.

J. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

K. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

L. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

M. Install supports for vertical piping and anchors as recommended by pipe manufacturer. Support vertical piping inside wall cavity at vertical pipe drop connection and half way between drop connection and plumbing fixture.

N. Spacing less than indicated above may be required to conform to building structure design or loading limitations.

O. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

P. Place hangers and supports within one foot of either side of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" and larger.

3.3 INSULATION PROTECTION SHIELDS

A. Install insulation protection shields at support points as specified under Insulated Pipe Supports.

B. Use one shield (bottom) for clevis hanger and 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.4 INSULATED PIPE SUPPORTS

A. Install insulated pipe supports at support points of all insulated pipe.

B. Pipe Size 1-1/2" and Smaller:

1. Use insulation protection shields or pre-insulated pipe supports. Pipe insulation specified in Section 220700 - Plumbing Systems Insulation shall be continuous through support points.

C. Pipe Size 2" and Larger:

1. Use pre-insulated pipe supports.
2. In lieu of pre-insulated pipe supports, field-assembled insulated pipe supports may be used. If used, submit application details including materials, thickness, compression strength, load bearing surfaces, load calculations of support assembly and total pipe weight based on support spacing.
3. Field-assembled insulated pipe supports shall consist of weight bearing insulation inserts and insulation protection shields.
4. Insulation protection saddles may be used in lieu of assembled insulated pipe supports on roller hangers/supports for hot water pipes, low pressure steam and steam condensate pipes.

3.5 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 3/8" or smaller and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping. C-clamps are not allowed for hot water piping.

3.6 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

B. Determine trapeze supports spacing by the smallest pipe on trapeze.

3.7 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be reviewed and approved by Structural Engineer prior to installation.

3.8 RISER SUPPORTS

A. Insulated Piping:

1. Unless otherwise indicated, support vertical piping as indicated below:

a. Support vertical piping at bottom of riser, secured and anchored to building structure. Provide guides on vertical piping.
b. Guide vertical piping 2” and smaller at every floor. Guide 2-1/2” and larger at every other floor.

2. Maximum vertical support spacing shall be10 ft.

B. Non-insulated Piping:

1. Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast-iron pipes shall be 15 ft.
2. Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be10 ft.
3. Install riser clamps and intermediate supports as required.
4. Rest riser clamps on floor or on pipe sleeve.

3.9 PIPE ROOF PENETRATION PROTECTIONS

A. Install at points where pipes are penetrating roof. Install as shown and according to manufacturer's installation instructions.

END OF SECTION 220529

SECTION 220553 - PLUMBING SYSTEMS IDENTIFICATION

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 SUBMITTALS

A. Product Data: For identification materials and devices.

B. Valve Schedules: For each piping system as specified in this Section.

C. Paint schedule: For each piping system as specified in this section.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

A. Stencil Paint:

1. Oil-based, alkyd enamel, black color.

B. Valve Tags:

1. Provide minimum 1-1/2" diameter, 0.032" thick, polished brass tags on all valves.

C. Laminated Plastic Nameplates:

1. ASTM D 709, Type I, cellulose, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore.
2. Nameplates shall be approximately 1-1/2" x 4", 1/16" thick, and have 1/2" high lettering. Face of plastic shall be black with white letters.
3. Fasteners shall be self-tapping, stainless steel screws or contact-type with permanent adhesive.
4. Provide permanent adhesive, laminated plastic nameplate identification marked “SHUT-OFF VALVES” for all valve locations above all ceilings. Nameplate shall be installed in as unobtrusive a manner as possible.

PART 3 - EXECUTION

3.1 GENERAL

A. This project will involve painting of all exposed plumbing and fire protection piping. Where piping is required to be insulated, PVC color coded cover jacket shall be applied over the required insulation and jacket.

B. After painting and/or PVC covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

C. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker material for those applications.

D. Pipe identification labels and pipe paint or PVC pipe insulation jacket cover colors shall be as follows:

Piping System	Pipe Abbreviation	Pipe Label	Pipe Paint or Jacket Color
Fire Protection	FIRE	Black	Red
Fire Sprinkler	FIRE SPRINKLER	Black	Red
Domestic Cold Water	DOMESTIC/LAB COLD WATER SUPPLY	Black	Green
Domestic Hot Water Supply	DOMESTIC/LAB HOT WATER SUPPLY	Black	Green
Domestic Hot Water Return	DOMESTIC/LAB HOT WATER RETURN	Black	Green
Non-Potable Water	NPW	Black	Purple
Natural Gas	NATURAL GAS	Black	Yellow
Sanitary Waste	SANITARY WASTE	Black	N/A
Sanitary Vent	SANITARY VENT	Black	N/A
Storm	ROOF DRAIN	Black	
Equipment Hangers and Attachments		Black	
Notes: “XX” = System Pressure Use Black Jacketing for any exposed service in architecturally finished “black” ceiling cavity Paint jacketing or exposed pipe for any exposed service per Architects direction in architecturally “finished” spaces			

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe identification on each system. Place flow directional arrows at each pipe identification location.

B. Identify all piping, not less than once every 25 ft, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls, floors, at major equipment and any other points of origination and termination.

C. Identify piping with piping stencils.

D. Markers to comply with ANSI A13.1 for color, length of color field and include flow directional arrows integrated into the marker.

E. For insulated pipe systems, lettering sizes are as follows;

1. For pipes up to 1 inch, use 1-inch letters.
2. For pipes 1-1/4 inch to 2 inches, use 2-inch letters.
3. For pipes 2-1/2 inches to 6 inches, use 3-inch letters.
4. For pipes above 6 inches, use 4-inch letters.

F. For uninsulated systems, lettering sizes are as follows:

1. For pipes up to 1 inch, use ½ inch letters.
2. For pipes 1-1/4 inch to 2 inches, use 1-inch letters.

G. Insulated piping in exposed areas shall have colored PVC jacketing. Piping in all other areas will have color coded banding provided at each location where pipe marker occurs. Refer to Color Chart for banding colors.

3.3 VALVE IDENTIFICATION

A. Identify valves with brass tags bearing valve identification number. Attach tag to valve body with brass jack chain and “S” hook.

B. Valve number shall be prefixed with corresponding piping system identification letters.

C. Furnish typewritten charts indicating fixtures, equipment or areas served by each numbered valve and incorporate in O&M Manuals. Provide additional typewritten copy of valve schedule with plastic protective covering and locate in conspicuous area within each mechanical equipment room.

D. All tagged valves shall be identified on a set of as-built drawings and provided inside of 3" PVC pipe with removable caps. Locate drawings in mechanical room MH01and mount horizontally on wall. PVC pipe shall be stenciled with "AS-BUILT DRAWINGS".

3.4 EQUIPMENT IDENTIFICATION

A. Identify all major equipment, including pumps, water heaters, tanks, control panels, etc.

B. Identify equipment with oil-based enamel paint that contrasts with the equipment finish, or with laminated plastic nameplates.

C. Identify control equipment with oil-based enamel paint that contrasts with the equipment finish, or with laminated plastic nameplates.

D. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if they are not located for easy reading.

3.5 CONCEALED VALVE AND EQUIPMENT IDENTIFICATION

A. Provide additional identification on adjacent finished surfaces for all valves and equipment located in concealed spaces. Example: colored buttons on underside of ceiling grid track to identify hot and cold water shut-off valves located above ceiling.

3.6 ACCESS PANEL IDENTIFICATION

A. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

3.7 SPRINKLER ZONE CONTROL VALVE IDENTIFICATION

A. Identify sprinkler zone control valves with laminated plastic nameplates. Nameplate shall include name of sprinkler zone served and description of area served.

B. Identify inspector's test valve with laminated plastic nameplate if valve is located remote from sprinkler control valve. Nameplate shall include name of sprinkler zone served.

3.8 UNDERGROUND WARNING TAPE

A. Install detectable warning tape 4" to 6" below grade, above all pipe outside of buildings to allow for accurate above surface detection.

END OF SECTION 220553

SECTION 220594 – DOMESTIC WATER SYSTEMS TEST ADJUST BALANCE

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 RELATED WORK

A. Section 221100 – Water Distribution System

B. Section 222114 – Plumbing Specialties

1.3 DESCRIPTION

A. TAB Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work of all liquid fluid handling systems (i.e., heating hot water, chilled water, etc.). Work shall include balancing branch takeoffs serving floor / zone, coils, pumps, and other processes included in this project.

B. Work required shall consist of setting volume flow rates, adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes liquid fluid handling systems as defined by drawings and/or schedules.

E. Procedures shall be in accordance with the latest edition of AABC or NEBB and as per detailed herein.

F. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval.

G. Contractors who are members of AABC or NEBB and who have qualified personnel available to perform Work may submit Quality Assurance Submittal for approval. Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

H. Upon direction of Architect/Engineer or TAB subcontractor, Contractor shall provide (at no additional cost to Owner) any additional work and/or devices necessary to properly balance the system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at minimum pressure differential.

I. TAB work shall not proceed until all assigned personnel have been approved by, Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be complete before occupancy. Certificate of Final Acceptance shall not be issued until after Final Report is accepted by Engineer.

1.4 SUBMITTALS

A. General:

1. Make submittals in accordance with project submittal procedure.
2. Reports shall be assembled using 3 ring hard cover binder with project name and location on cover and side panel. All information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Provide numbered tabs for each system. Provide sortable electronic version as well as hard copy. Assemble the report in the following order:

   a. Transmittal letter
   b. Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer.
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:

      1) Equipment data and measurement summary
      2) Equipment measurement data
      3) Branch main measurement data
      4) Terminal device measurement data arranged by floor and by room.

B. Quality Assurance Submittal:

1. Within 30 days of signing contract, Contractor shall submit the following information:

   a. Firm resume

      1) AABC or NEBB active membership certificate
      2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

   b. Supervisor resume
   c. Balance technician(s) resume. Submit only resumes for those individuals who will be onsite and actively working on the project.

2. A/E and/or Owner reserves the right to contact previous project representatives and to reject persons whom A/E and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects. All persons performing work shall be AABC or NEBB certified.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to A/E and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any field work starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to A/E and Contractor incomplete work or problem areas to be resolved before final balance is completed.
2. Initial test report to identify all deficiencies. Deficiencies to be corrected or addressed before submitting a final report.

E. Final Report:

1. Final report shall be submitted to Designer at least 10 days prior to the Final Inspection. The Final Report shall also be available at the Final Inspection for the Designer and State Construction Review. Submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC and American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by A/E upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards.

C. Calibration of equipment shall be recent but not more than 1 year old.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete field work, submit reports, and correct any deficiencies as noted by Engineer before start of commissioning activities. Follow procedures outlined herein and as described in Planning Phase narratives.

B. TAB Contractor shall coordinate and arrange an onsite meeting with Construction Manager, Engineer, Controls Contractor, Mechanical Contractor, and Commissioning Agent prior to start of TAB work to discuss methodology for testing systems and review any outstanding work to be performed which may impact TAB work.

C. Set point for shall be the flow rate defined on the schedules.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for pumps, flow measuring devices, and all terminal devices and include performance curves with actual operating points noted in Final Report. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.

2. Narratives: furnish written narratives of all procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow measuring devices to be used at each terminal device. Include different narratives for constant and variable flow systems. For non-standard water systems, include narratives on how to measure and adjust for different viscosities. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include the specified adjustment tolerances. Include voltage/current readings for each phase of 3 phase motors on TAB data sheets.
3. Pre-balance Checklist: shall include, but not be limited to:
   a. Check for completeness of work
   b. System cleaning
   c. System fill and air venting
   d. Place system into operation
   e. Pump bearings, alignment, starters, vibration isolators, rotation
   f. Setting valves to specified position including shutoff and bypass valves
   g. Set up of controls and control devices
4. Measuring Instrument List: list measuring instruments to be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
   a. Manufacturer name and model number
   b. Measurement range
   c. Pressure/temperature limits
   d. Date put into service
   e. Date of last calibration
   f. Certificate from calibration firm
5. A/E reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument which has not been recalibrated within past year.
6. Samples: submit copies of TAB forms to be used.
7. Branch circuit and terminal measurements and adjustments: indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flows (include zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial setpoint of differential pressure transmitters on forms.

3.3 SET-UP PHASE

A. Procedure:

1. Perform pre-balance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure all pump data and flows in "as found" condition after initial valve settings are made.

C. Initial Test Report:

1. Submit report to A/E and Mechanical Contractor indicating all measurements made and make notes of all items which are not complete or are not within design tolerance. Final balancing shall not occur until all deficient items identified are corrected by the Contractor.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

1. Submit report to A/E, Commissioning Agent, and to Mechanical Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports. Do not submit handwritten reports in lieu of typed reports. Submit final report at least 10 days prior to date of Final Inspection.
2. Report shall include deviation from design setpoints as a percentage.

C. Final Report Adjustments:

1. A/E reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance of design flow. TAB Contractor shall revise system balance and resubmit all or portions of Final Report as directed by A/E.

END OF SECTION 220594

SECTION 220700 - PLUMBING SYSTEMS INSULATION

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 DESCRIPTION

A. Provide all insulating materials and accessories as required for mechanical systems as specified below.

B. All insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.3 DEFINITIONS

A. Concealed areas, where indicated in this section, shall apply to shafts, furred spaces, space above finished ceilings, low tunnels and crawl spaces. All other areas shall be considered as exposed.

B. Interstitial spaces are considered as concealed areas.

1.4 SUBMITTALS

A. Shop drawings for each piping system for all pipe sizes, each ductwork system and all equipment including, but not limited to, the following:

1. Manufacturer's name
2. Schedule of all insulating materials
3. Insulation material and thickness
4. Jacket
5. Adhesives
6. Fastening methods
7. Fitting materials
8. Intended use of each material
9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
10. Insulation installation details (manufacturer’s installation instruction/details, Contractors installation details, MICA plates where applicable.)
11. All other appropriate data

1.5 DELIVERY, STORAGE AND HANDLING

A. All insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather tight transportation. Insulation materials delivered to jobsite shall be stored so as to protect materials from moisture and weather during storage and installation. Insulation material shall be protected from long exposure to UV light from sun.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Owens Corning, Johns Manville, Knauf or Certain Teed similar to product indicated except where product of another manufacturer is specifically identified for special type of insulation.

2.2 MATERIALS

A. Unless otherwise indicated, all products, material itself or on a composite basis, shall meet ASTM E-84, UL 723 or NFPA 255 and shall not exceed 25 flame spread and 50 smoke developed.

2.3 INSULATION

A. Fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation, where indicated, shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be equal to PK Quick Cote, or Ryder GP, with dry density of no more than 38 lb/ft3 and thermal conductivity of .63 at 400°F mean temperature.

D. Filling and finishing cement shall be equal to PK Super Stik, or Ryder MW, with dry density of no more than 24 lb per cu ft and thermal conductivity of .74 at 500°F mean temperature.

E. Type R Insulation (Rigid Glass Fiber):

1. Minimum nominal density of 3 lb/ft3 with thermal conductivity of not more than 0.23 at 75°F mean temperature and 0.30 at 200°F mean temperature.
2. Pipe insulation shall be suitable for temperature to 850°F and shall be Johns Manville Micro-Lok 850, Owens-Corning Fiberglass ASJ/ SSL-II.

F. Type A Insulation (Closed Cell Elastomeric Thermal Insulation):

1. Minimum nominal density of 6 lb/ft3, thermal conductivity of not more than 0.27 at 75°F mean temperature, maximum water vapor transmission of 0.1 perm inch and suitable for temperature from -40°F to 220°F.
2. Type A insulation may be provided for piping installed in walls or for condensate waste piping only.

2.4 JACKETS

A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 procedure A.

B. Type P-2 Jackets:

1. Factory applied paper free service jacket and SSL II adhesive closure system. Jacket shall have neat, white finish suitable for painting, with beach puncture resistance of 50 units minimum. Permeance shall not exceed 0.02 perm. Owens Corning "Evolution".

C. Type E-1 Jacket:

1. Inner layer shall be heavy duty material consisting of 30-pound rosen paper. Attach inner layer with 3/4-inch pressure sensitive tape. Cover inner layer with 8-ounce canvas lagging cloth adhered with Childers CHIL-SEAL CP 50A, Bimasco #136 or Insulcoustic #102 coating. Finish coat shall be second sizing coat of Childers CHIL-SEAL CP 50A, Bimasco #136 or Insulcoustic #102.
2. Provide Type E-1 Jacket in addition to Type P-1 jacket as shown in schedule.

D. Type V-1 Jacket:

1. Fire retardant and UV resistant PVC in minimum 20 mil (0.02") thickness consisting of preformed fitting covers, preformed end terminations, and sheet material for straight runs of pipe. Material when installed according to manufacturer's instructions shall provide complete vapor barrier and readily cleanable surface while meeting Federal CGMP requirements.
2. Jacketing system shall be equal to Johns Manville Zeston/Perma-Weld System. Similar product by PROTO will be acceptable.

2.5 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Products shall be compatible with surfaces and materials on which they are applied and be suitable for use at operating temperatures of systems to which they are applied.

B. Products shall be fire retardant, moisture resistant, mildew resistant and vermin proof.

C. Adhesives, mastic, sealants, and protective finishes shall be as recommended by insulation manufacturer for application specified.

D. Glass fiber fabric reinforcing shall be 10 x 10 or 20 x 10 mesh.

E. Wire mesh reinforcing shall be 22 gauge 1" galvanized.

F. Insulation cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

G. Finishing cement to be ASTM C449.

H. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373 or Manville 57.

2.6 METAL BANDS AND WIRES

A. Aluminum bands to be 0.5" x 0.020" up to 48" OD and .75" x 0.020" over 48" OD.

B. Stainless steel bands to be 0.5" or 0.75" x 0.015".

C. Stainless steel wires to be 16 gauge.

PART 3 - EXECUTION

3.1 APPLICATION

A. Provide Insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise.

Piping System							
Service	Jacket Type	Insulation Type	Insulation Thickness According to Pipe Size				
			1" & less	1-1/4"-2"	2-1/2"-4"	5"-6"	8" & Larger
Domestic/Lab Cold, Non-Potable Cold	P-2	R	1"	1"	1"	1"	1"
Domestic/Lab Hot, Domestic/Lab Hot Return	P-2	R	1”	1”	1-1/2”	N/A	N/A
Cold Condensate Waste Piping	V-1	A	1”	1”	N/A	N/A	N/A
All Storm Piping	P-2	R	N/A	1”	1”	1”	1”
Ice Machine waste	V-1	A	1”	1”	N/A	N/A	N/A
Waste vent piping to 18” from roof penetration	P-2	R	N/A	1”	1”	1”	1”
All piping within mechanical equipment rooms and in exposed areas.	Provide Type E-1 or V-1 jacket in addition to pipe insulation and jacket specified in this schedule. Refer to 220553 for required jacket color.						

3.2 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards and manufacturer's installation instructions, except as modified in this Section of specifications.

B. Install all products with good workmanship, with smooth and even surfaces. Use full length factory furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system, which must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects, prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

E. Provide beveled terminations at name plates and uninsulated fittings.

F. Make longitudinal joints in jackets, where possible, facing toward wall or ceiling.

G. Apply insulation to each pipe individually. Common insulation applied for adjacent pipes will not be accepted.

H. Unless otherwise indicated, pipe insulation shall be continuous through walls and floors.

I. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

J. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 078400 Systems Firestopping.

K. Insulate the following systems for complete vapor barrier protection.

1. Cold water systems
2. Cold water condensate
3. Storm water

3.3 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, and fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly.

B. Laps on factory applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or be pressure sealing type lap.

C. Joints shall be covered with factory furnished tape (3" minimum width) to match jacket, firmly cemented with lap adhesive.

D. Secure insulation, except those with vinyl jackets, additionally with staples.

E. Where staples are used, they shall be on 6" maximum centers, and when used for system requiring vapor barrier, lap and staples shall be covered with finish coat of lagging adhesive.

F. Built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with jute twine, or built up with insulating cement, and finished to smooth hard surface, and covered with minimum of 9 oz per sq yd rewettable glass cloth.

G. For valves and fittings requiring vapor barrier, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For valves and fittings not requiring vapor barrier, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric, after application of insulating cement. Apply coating in accordance with manufacturers recommended procedure.

H. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

I. For pipes 1-1/2" and smaller, specified pipe insulation and jacket shall be continuous through hanger or support locations and insulation protection shields or pre-insulated pipe supports shall be provided to protect insulation from compressing.

J. For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on all hot and cold systems at pipe supports.

K. For pre-insulated pipe supports and insulation protection shields, refer to Section 220529 – Plumbing Supporting Devices.

END OF SECTION 220700

SECTION 221100 - WATER DISTRIBUTION SYSTEM

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 DESCRIPTION

A. This Section covers all interior domestic cold water, domestic hot water, domestic/lab hot water return, and non-potable cold-water piping inside the building.

1.3 QUALITY ASSURANCE

A. Order pipe with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

E. Before shipping, piping shall be cleaned, free of rust and scale, and chemically treated to protect inside of pipe from rusting and furnished with end caps.

1.5 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe
2. Fittings
3. Joints
4. Valves
5. Water meters
6. Unions
7. Dielectric fittings
8. Water hammer arrestors
9. Pumps

B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 PIPE, FITTINGS, AND JOINTS – ABOVE GRADE

A. Copper (2-1/2" and Smaller):

1. Pipe: Copper tube, Type L, hard drawn, ASTM B88.
2. Fittings:
   a. Cast bronze, solder joint, pressure rated, ANSI B16.18.
   b. Wrought copper, solder joint, pressure rated, ANSI B16.22.
3. Joints: Lead free, 95-5 (<0.2%) solder, Bridgit or Silvabrite, ASTM B32, flux, ASTM B813.
4. Nipples: Red brass pipe, threaded.
5. Press Joint Option:
   a. Contractor may use press copper fittings as manufactured by Viega. Other acceptable manufacturers are Nibco and Elkhart.
   b. Fittings: Copper press fittings with EPDM seal, 0 to 250°F, maximum 200 psi.
   c. Joints: Press joints by fitting manufacturer approved tool.

B. Copper (2-1/2" and Larger):

1. Pipe: Copper tube, Type L, hard drawn, ASTM B88.
2. Fittings:
   a. Cast bronze, solder joint, pressure rated, ANSI B16.18.
   b. Wrought copper, solder joint, pressure rated, ANSI B16.22.
3. Joints: Brazed, BcuP-5 type, AWS A5.8, 1250°F minimum melting point.
4. Nipples: Red brass pipe, threaded.

2.3 UNIONS AND FLANGES

A. General:

1. Unions, flanges and gasket materials to have pressure rating of not less than 150 psig at 180 degrees.

B. Copper 4" and Smaller:

1. Wrought copper union, Nibco Figure 733. Mueller Brass equal.

2.4 VALVES

A. Acceptable manufacturers: Apollo, Crane, Hammond, Milwaukee, Nibco, Stockham and Watts with indicated features and equal to model listed. Note that not all manufacturers make all sizes.

B. Shutoff Valves:

1. Ball Valves:

a. Full Port, 2 Piece for valves 1-1/4" and smaller: Bronze body, ASTM B584, stainless steel ball, teflon seats, insulation stem extension, 600 psi WOG pressure rating.
b. Full Port, 3 Piece for valves 1-1/2" and larger: Bronze body, ASTM B584, stainless steel ball, teflon seats, stem extension, tube extensions, 600 psi WOG pressure rating.
c. Insulated Handle: For insulated systems to prevent condensation on the valve body with thermal and vapor seal.

2. Butterfly Valves (3" and larger):

a. Acceptable Manufacturers: Crane, Hammond, Milwaukee, Kitz and Stockham with indicated features and equal to model listed. Note that not all manufacturers make all sizes or styles.
b. Lug Type: Ductile iron body, aluminum bronze disc, EPDM liner, 316 stainless steel stem, brass bushings (lower, upper and collar), 200 psi WOG pressure rating, lever handle through 6", gear operator 8" and larger.

C. Check Valves:

1. Swing Check Valves 3" and Smaller:

a. Bronze body, ASTM B62, Y pattern, Buna-N resilient disc, horizontal swing, 200 psi WOG rating, Nibco 413.

2. Lift Check Valves 2" and Smaller:

a. Bronze body, ASTM B62, in-line lift type with spring, Buna-N disc, 250 psi WOG rating, Nibco 480.

3. Spring Loaded Check Valves 1/2" thru 2":

a. Stainless steel body, in-line pattern, stainless steel seats, spring and valve disc. Durabla Basic Check, Model BSS, rated for 300 psi WSP.
b. Manufacturers: Nibco, Watts, Mission, Durabla, Circle Seal, Milwaukee, Stockham.

D. Balancing Valves:

1. Constant Flow Balancing Device:

a. Acceptable Manufacturers: IMI Flow Design, Caleffi; Eaton, or Victaulic
b. 1/2" thru 1": Nickel plated lead-free brass or 316 stainless steel body, flexible Buna-N insert that acts as variable orifice. Flow rates to be maintained to within ± 15% up to pressure drops of 125 psig, equal to IMI Flow Design Model ICSS, Caleffi; Flow Cal 127 series or approved equal.

E. Solenoid Valves

1. General service 2-way solenoid valve with brass body, 120 volts AC, equal to ASCO 8210 general purpose. Coordinate power connection with Electrical Contractor.

2.5 THERMOSTATIC CENTRAL TEMPERED WATER MIXING VALVE (TMV-1)

A. Acceptable manufacturers: Lawler, Leonard, Powers or approved equal

B. Master thermostatic mixing valve, capable of maintaining mixed water temperature within 5°F of setpoint at zero demand and peak flow with recirculated flow for temperature maintenance. Valve assembly shall be capable of sensing temperature in recirculated water temperature and returning water to main distribution if temperature is adequate or diverting partial flow to heater when temperature falls below setpoint.

C. Mixing valve shall be bronze construction with dual thermostatic elements, integral thermometer, check valves, strainer, visual flow indicator and integral thermostatic return limiter. Valve shall be rated for 150 psig operating pressure and be certified under ASSE 1017.

D. Mixing valve shall be furnished with a low flow mixing valve and high flow mixing valve.

E. Mixing valve station shall be furnished with integral recirculation pump. Refer to schedule on drawings for pump performance.

F. Refer to schedule on drawings for valve performance.

2.6 COMPOUND WATER METERS

A. Water Meter shall be provided by controls contractor and installed by plumbing contractor. Refer to 230903 Controls Instrumentation for Water Meter specification.

2.7 DIELECTRIC FITTINGS

A. Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation.

B. Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180 degrees. Watts Regulator Company, Victaulic or Zurn/Wilkins.

2.8 WATER HAMMER ARRESTORS

A. Mechanical Water Hammer Arrestors:

1. PDI W-201, piston-compressed air column or stainless-steel bellows type with sealed air chamber.
2. Manufacturers: Josam, J.R. Smith, or Zurn, equal to size shown on drawings.

2.9 EXPANSION JOINTS/LOOPS

A. Copper Tubing:

1. Mechanical expansion fittings, size (3/4” thru 4”), copper tube sweat ends, stainless steel laminated internal bellows, (200 psi) working pressure, (600°F) rated; Keflex Model 7QT. Do not braze.
2. Allowable length of copper tube per mechanical expansion fitting shall be in accordance with the following table:

System Operating Temperature	Length of Pipe
110°F	300 ft
120°F	275 ft
130°F	250 ft
140°F	225 ft

B. Pre-manufactured expansion loop will be allowed: Metraflex Model MLS Series for sweat ends, MLT Series for threaded ends and MLF Series for flanged or groove ends. Verify pipe size required, laying length, and face-to-face dimension required. Coordinate location with other trades.

2.10 IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Armstrong, Bell and Gossett, or Grundfos.

B. Pumps shall be NSF rated, pipeline mounted, single suction type with cast iron casing, bronze fitted with working pressure of 175 psi and operating temperature of 225°F continuous, 250°F intermittent.

C. Casings shall have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

D. Impellers to be single suction enclosed type made of bronze, hydraulically and dynamically balanced, keyed and locked to carbon steel pump shafts and protected by replaceable bronze shaft sleeves.

E. Pump shall be controlled and monitored by Building Automation System (BAS).

F. Pump shafts shall be steel or stainless steel, sealed and gasketed from pumped fluid.

G. Pumps shall be furnished with mechanical carbon/silicon carbide seals.

H. Bearing assemblies shall be permanently oil lubricated and maintenance free.

I. Refer to schedule on Drawings for capacity requirements of pumps.

J. Pumps motors shall have variable speed Electronically Commutated Motor (ECM).

K. BACnet communication capabilities to relay all monitoring and alarm signals to the Building Automation System (BAS).

2.11 PRESSURE BOOSTER PUMP

A. Manufacturers: Bell & Gosset, Hyfab, SyncroFlo, equal to Grundfos.

B. Booster pump package shall comply with ASHRAE 90.1-2010 and shall have components frame mounted, piped, painted, wired and factory tested. Package shall include triplex pumps, hydro-pneumatic bladder tank if package not provided with logic control for pump shut-down, and control panel. Pumps shall be configured to run in lead-lag-lag sequence. Package shall have single 460V 3 Ph power connection with transformer provided for lower voltage requirement. Pump package shall be provided with auto-restart function on loss of power.

C. Pumps shall be vertical close coupled end suction type.

D. Pumps shall have iron or stainless-steel volute, stainless steel or bronze impeller, single suction enclosed type, keyed to shaft, hydraulically and dynamically balanced; stainless or carbon steel shaft with stainless steel or bronze sleeve; mechanical seals with carbon rotating against stationary ceramic seat.

E. Pumps shall be rated at 125 psig maximum working pressure and 225°F continuous temperature. Manufacturer shall certify ratings.

F. Pumps shall run without excessive noise or vibration.

G. Provide spare pump seals for each pump.

H. Each pump shall have high efficiency motor sized for non-overloading over entire pump curve.

I. Each pump and motor to have nameplate listing manufacturer's name, pump serial number, capacity in gpm and ft. of head at design conditions, motor horsepower, voltage, frequency, speed, and full load current.

J. Pumps shall have manufacturer supplied VFD for each pump.

K. Provide dedicated check valves on the outlet of each pump.

L. Pump manifold shall have inlet and outlet pressure gauges.

M. Provide isolation valves at inlet and outlet of each pump. Valves shall be butterfly or ball valves as specified previously. Piping shall be removable from either side of isolation valves without removing isolation valves to allow for complete pump removal.

N. Pump manifold piping shall be type 304 stainless steel.

O. Package shall be controlled by skid mounted, UL listed NEMA 1, ICS 7.1 control panel with following components:

1. Pressure transducers
2. Control circuit transformer with protected secondary
3. Time delays
4. Minimum run timers
5. Adjustable solid-state current sensing relays
6. Low suction pressure cutout
7. High suction pressure shutdown
8. Two sensor differential temperature no-flow shutdown
9. Pump operation and warning lights, and alarm horn
10. Automatic pump alternation of pumps 1, 2, and 3
11. Controller shall be provided with a touch-screen interface panel with graphics, trending, and alarm functionality.
12. BACnet communication capabilities to relay all monitoring and alarm signals to the building automation system (BAS).
13. Controls shall include Demand based control as required by ASHRAE 90.1 to modulate the VFD response based on the actual demand
14. Controllers and controls hardware shall be non-proprietary. The controls shall be warranted for parts and labor for 5 years.
15. Magnetic starter for each motor with overload protection, external resets, and starter failure interlocks
16. Single door interlocked disconnect
17. H-O-A switch for each pump

P. Provide extra set of dry contacts in control panel for transmission of general fault alarm to Building Automation System.

Q. Hydro-pneumatic bladder tank if required shall be ASME rated with ring stand base and replaceable bladder. Tank shall include inlet and outlet pressure gauge, bladder charge pressure gauge and pressure switch for pump control.

R. Refer to schedule on Drawings for capacity requirements of pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations, and recognized industry practices.

B. Maintain piping system in clean condition during installation. Remove dirt and debris from assembly of piping as work progresses. Cap open pipe ends where left unattended or subject to contamination.

C. Include connections to plumbing fixtures, and to equipment requiring water. Provide proper backflow and back siphonage protection to safeguard potable water system from contamination.

D. Lay out water system so as to conform to intent of drawings. Coordinate piping with building features and work of other trades. Plans indicate, general routing, provide additional offsets as required. Install piping with necessary swing joints and offsets to allow for expansion. Install shut-off valves on branch lines near mains to avoid long dead-leg branches when valves are closed. Install water piping plumb and square with building. Pitch water pipe to drain with drain valves at low points.

E. Install shut-off valves where indicated, at base of risers and at floor level takeoffs from risers to allow isolation of portions of system for repair. Do not install water piping within exterior walls.

F. Provide protective sleeve covering of elastomeric pipe insulation where copper or steel piping is embedded in masonry or concrete

G. Provide dielectric fittings between dissimilar piping materials.

H. Do not route piping through transformer vaults, telecom rooms or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

I. Install all valves and piping specialties, as specified and/or detailed. Provide access to valves and specialties for maintenance. Make connections to equipment, fixtures, and systems where same requires piping services indicated in this section

J. Access panels shall be provided where shutoff valves, air chambers, or other equipment is located in chases or other concealed spaces. They shall be fire rated where required and equipped with full piano hinge. Access panels shall be of sufficient size for maintenance of equipment and key lockable in public areas.

K. Do not install water piping within exterior walls.

L. Provide drain valves at base of risers and at low points of trapped piping 2” and larger where trapped water volume exceeds 5 gallons.

M. Provide dielectric fittings between dissimilar piping materials.

N. Install water pipe using proper pipe and fittings. Use reducing fittings for changes in pipe size.

O. Threaded Pipe Joints:

1. Make threaded pipe joints with square cut and reamed pipe. Provide tapered pipe threads in conformance with ANSI B2.1.
2. Cut threads so that exposed threads at joint are less than three. Coat exposed threads with asphaltum or other corrosion inhibiting substance. Use joint compounds or teflon tape on pipe threads to achieve leak free joint.

P. Soldered Copper Pipe Joints:

1. Use non-acidic and lead-free flux on cleaned pipe and fittings for soldered joints.
2. Cut pipe square and ream before assembly.
3. Fill joints with solder by capillary action. Solder shall cover joint periphery. Wipe joint clean.
4. Apply heat carefully to prevent damage to pipe, fittings and valves.
5. Follow manufacturer's recommendations when heating valves and equipment for soldered connections.

Q. Brazed Copper Pipe Joints:

1. Cut pipe square and ream before assembly.
2. Joints shall be cleaned and polished before brazing.
3. Flux of any type shall not be used.
4. Apply heat carefully to prevent damage to pipe, fittings and valves. Disassemble valves where possible to prevent damage to seats during brazing.
5. Purge lines with dry nitrogen during brazing.

3.2 ARRESTORS

A. Use water hammer arrestors to control water hammer. Installed devices shall be sized and located according to manufacturer's recommendations or as shown on drawings.

B. Use water hammer arrestors with flush valves and all quick-closing valves.

3.3 DIELECTRIC UNIONS AND FLANGES

A. Install dielectric unions or flanges at points where copper-to-steel pipe connection is required in domestic water systems.

B. Install unions on equipment side of shutoff valves for items such as: water heaters, water softeners, pumps, filters, and similar equipment requiring periodic replacement.

3.4 EXPANSION JOINTS

A. Install one anchor on either side of expansion joint, opposite direction of expansion.

B. Install pipe guides on each side of mechanical expansion fittings.

3.5 CLEANING

A. Flush and clean piping prior to testing. Remove corrosion by mechanical or chemical means. Use chemicals that are NSF rated.

3.6 TESTING

A. Refer to Testing paragraph of Section 220000 - General Plumbing Requirements.

B. Water test system may be applied to system in its entirety or in sections. Test piping with water to pressure of 150 psi for 24 hrs. No decrease in pressure allowed. Provide pressure gauge with shutoff and bleeder valve at highest point of system tested. Inspect joints in system under test.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not conceal pipe until satisfactorily tested.

E. Testing with air will not be allowed.

3.7 BALANCING

A. Balance water distribution systems. Adjust control valves for proper operation. Set balancing valves to maintain hot water in hot water system.

B. Balance flush valves, flow control valves and mixing valves for adequate flow and temperature to plumbing fixtures and equipment.

3.8 DISINFECTION

A. Disinfect water piping in the following manner:

1. Clean and flush water pipe with water until water at remote tap is clear.
2. Fill water systems with solution containing 50 ppm of chlorine (minimum concentration). Allow solution to stay in water system for 24 hours. Alternately use solution of 200 ppm of chlorine (minimum concentration) for 3 hours.
3. Flush water system of chlorine solution.
4. Allow clean water to stand in system for 24 hours. Take sample from remote tap for bacteriological test.

B. Do not use water system for potable water supply until safe bacteriological test is obtained. Repeat steps 1 through 4 until safe water system is obtained.

3.9 BACTERIOLOGICAL TESTS

A. Take representative water samples and test to ensure bacteriologically safe water supply system. Include HPC (Heterotrophic [Standard] Plate Count) test and test for presence of Pseudomonas aeruginosa as well as regular coliform bacteria test. HPC test maximum containment level of 500 organisms/ml. Perform bacteriological tests shortly before Owner's acceptance of building. If tests fail, correct and retest.

END OF SECTION 221100

SECTION 221300 – SANITARY WASTE AND STORM DRAINAGE 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 DESCRIPTION

A. This Section includes materials and methods for sanitary waste piping, sanitary vent piping, force mains, indirect waste piping and storm drainage piping systems within the building and up to 5 feet outside the building.

1.3 QUALITY ASSURANCE

A. Order piping with each length marked with manufacturer's name or trademark and type of pipe; with each shipping unit marked with purchase order number, metal or alloy designation, temper, size, and supplier's name.

B. Installed material not meeting specification requirements must be replaced with material that meets these specifications without additional cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Promptly inspect shipments to ensure material is undamaged and complies with specifications.

B. Cover pipe to prevent corrosion or deterioration while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends from damage. End caps shall remain in place. Protect fittings by storage inside or by durable, waterproof, above ground packaging.

C. Offsite storage agreements will not relieve Contractor from using proper storage techniques.

D. Storage and protection methods must allow inspection to verify products.

1.5 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Pipe and fittings
2. Joints
3. Valves
4. Cleanouts
5. Floor drains and floor sinks
6. Air gap fittings
7. Pumps

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new, unless otherwise noted.

2.2 PIPE, FITTINGS, AND JOINTS

A. Above Ground Sanitary and Storm:
   1. Polyvinyl Chloride (PVC):
      a. Pipe: Schedule 40, Class 12454-B (PVC 1120), ASTM D178
      b. Fittings: Socket fitting, DWV patterns, ASTM D3311. Fabricated fittings shall be per ASTM F1866
      c. Joints: Primer, low VOC, ASTM F656; solvent cement, low VOC, ASTM D2564
   2. Copper
      a. Pipe: Type DWV copper tube, ASTM B306.
      b. Fittings:
         1) Cast copper drainage fittings (DWV), ANSI B16.23.
         2) Wrought copper drainage fittings (DWV), ANSI B16.29.
      c. Joints: 95-5 solder, ASTM B32; flux, ASTM B813.
      d. DWV Copper to Cast Iron Joints: Cast brass solder joint to cast iron caulk fitting.

B. Pressurized (Pumped) Interior Above Ground Force Main:
   1. Copper:
      a. Pipe: Type L copper tube, hard drawn temper, ASTM B88
      b. Fittings: Cast copper drainage fittings (DWV), ANSI B16.23
      c. Joints: Lead free (<0.2%) solder, ASTM B32; flux, ASTM B813

C. Adaptor Couplings for Joining Dissimilar Pipe Materials:
   1. Acceptable Manufacturers: Fernco, Mission and Cremco.
   2. 1" through 6" diameter: Fernco Proflex 3000 Series shielded coupling with neoprene gasket, stainless steel shield, and stainless-steel clamping bands. Adaptor couplings shall be specifically designed for the pipe materials being joined.

2.3 CLEANOUTS

A. Josam, Wade, Watts, Zurn or Smith, equal to number listed in Cleanout and Drains Schedule.

B. Provide recessed, solid brass, cleanout plugs where fittings are used as cleanouts. Provide taper-thread plug with Teflon tape thread wrap.

C. Floor Cleanouts: Cleanout with cast iron ferrule, adjustable top, nickel-bronze scoriated cover and frame, bronze taper-thread plug.

D. Floor Cleanouts, Unfinished Floors and Areas Outside Building: Cleanout with cast iron ferrule, adjustable round top, scoriated cast iron tractor cover, and bronze taper-thread plug.

E. Wall Cleanouts: Cleanout with cast iron counter sunk ferrule, bronze or brass taper-thread plug, secured stainless steel access cover.

2.4 FLOOR DRAINS AND FLOOR SINKS

A. Josam, Wade, Watts, Zurn or Smith, equal to number listed herein or in Cleanouts and Drains Schedule.

B. Floor drains shall be in accordance with ANSI A112.21.1. Provide with caulked or no-hub connection. Floor drains and floor sinks shall have internal seepage clamp collar for embedding in floor construction and weep holes to provide adequate drainage to drain pipe. Provide all floor drains and floor sinks with trap seal guard insert equal to ProSet.

2.5 ROOF DRAINS

A. Josam, Mifab, Wade, Watts, Zurn, or Smith equal to number listed in Cleanouts and Drains Schedule.

B. Roof drains shall have cast iron body with adjustable collar, cast iron flashing ring, gravel stops, cast iron dome strainer, and cast-iron underdeck clamp.

C. Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket.

2.6 AIR GAP FITTINGS

A. Air gap fittings constructed of cast iron with integral air gap having free area of at least twice the inlet area. Josam, Smith, Wade, Watts, or Zurn.

2.7 TRAPS

A. Same material as pipe or fittings unless specified with the fixtures. Refer to Section 224000 - Plumbing Fixtures. Provide 17-gauge brass, chrome plated traps for all exposed traps.

2.8 AIR ADMITTANCE VALVES

A. Acceptable Manufacturers: Proset, Watts, Studor

B. PVC body with diaphragm inlet valve, intake slots with screen.

2.9 SUMP PUMPS – ELEVATOR

A. Acceptable manufacturers: Stancor, Weil, Zoeller, Aurora/Hydromatic or approved equal.

B. Pump shall be submersible type constructed of epoxy coated cast iron shell, cast iron volute, two vane enclosed semi-open recessed cortex non-clog bronze impeller, stainless steel shaft, stainless steel fasteners, upper sleeve and lower ball bearing factory sealed grease lubricated, and ceramic mechanical seal.

C. Pump shall be hermetically sealed, capacitor start, built-in thermal overload protection sized for no-overloading entire pump curve.

D. Pump shall be of capacity and electrical service as indicated in the equipment schedules on the drawings.

E. Pump controls shall include:

1. Single on/off UL listed float switch
2. Alarm with dry contact to BAS

F. Pump accessories shall include:

1. Discharge check valve
2. Full port ball valve
3. Union for each pump

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install pipe and fittings in accordance with reference standards, manufacturer's recommendations, and recognized industry practices.

B. Avoid cleanout plugs in ceiling spaces. Install floor cleanouts in lieu of cleanout plugs. Provide floor cleanouts every 50 feet on all horizontal waste piping.

C. Connect piping to fixtures, each piece of equipment, and drains. Install required piping as shown on drawings.

D. Grade horizontal lines with minimum of 1/8" per foot, except piping 3" diameter or smaller which shall be run at 1/4" per foot slope.

E. Install piping parallel with building lines and at heights, which do not obstruct any portion of window, doorway, stairway, or passageway, except as may be shown on plans. Install overhead piping as high as possible.

F. Grade vent pipe for complete drainage by gravity to soil or waste pipes. Coordinate to prevent damage to roofing membrane.

G. Where interferences develop, offset or reroute piping as required to clear interferences. Coordinate locations of plumbing piping with piping, ductwork, conduit and equipment of other trades to allow sufficient clearances. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

H. Provide protective sleeve covering of elastomeric pipe insulation, where copper or steel piping is embedded in masonry or concrete.

I. Maintain piping in clean condition internally during construction.

J. Mitered ells, notched tees, and orange peel reducers are not allowed. Bushings are not allowed on threaded piping.

K. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless piping is serving this equipment.

L. Set floor drains true and level and protect properly throughout construction. Weep holes shall be filled with removable material and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Safe as specified.

M. Trap each fixture and piece of equipment requiring sanitary drainage connections. Trap seals shall be standard depth, except when deep seals are required by code. Traps shall be set true and level and located within the limits of code requirements. Traps shall not be used as separator, interceptor or other type of device to retain solids. Traps shall be provided with thread type approved cleanout plugs when specified. Protect traps during construction and seal off to prevent stones, debris, and other foreign matter from entering before use.

N. Provide plugs or caps for pipe openings during construction to prevent debris from entering pipe. Temporary plug shall be plastic cap or equivalent.

O. All underground nonmetallic piping shall have tracer wire.

P. All underground piping shall have warning tape installed above it 6 inches below finish grade.

3.2 COPPER PIPE

A. Remove slivers and burrs remaining from cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with metal brush, emery cloth or sandpaper. Remove residue from cleaning operation, apply approved, non-acidic flux and assemble joint to socket stop. Apply flame to fitting until solder melts when placed at joining. Remove flame and feed solder into joint until full penetration of cup and ring of solder appears. Wipe excess solder and flux from joint.

3.3 THREADED PIPE

A. Make joints for screwed pipe by cutting pipe square and reaming inside. Threads shall be cut so that end of pipe extends to shoulder of fittings. Exposed threads shall not exceed 3 in number and shall be painted with heavy coat of asphaltum. Use approved joint compounds, thread lubricant or teflon tape sparingly and only on outer threads.

3.4 POLYVINYL CHLORIDE (PVC) PIPE

A. Install in accordance with ASTM D2855 "Making Solvent Cemented Joints with PVC pipe and Fittings". Saw cut piping square and smooth. Tube cutters may be used if fitted with wheels designed for use with PVC pipe that do not leave raised bead on pipe exterior. Support and restrain pipe during cutting to prevent nicks and scratches. Bevel ends 10-15 degrees and deburr interior. Check dry fit of pipe and fittings. Reject materials, which are out of round or do not fit within close tolerance. Use heavy body solvent cement for large diameter fittings.

B. Maintain pipe, fittings, primer, and cement between 40°F and 100°F during application and curing. Apply primer and solvent using separate daubers (3” and smaller piping only) or clean natural bristle brushes about 1/2 size of pipe diameter. Apply primer to fitting socket and pipe surface with scrubbing motion. Check for penetration and reapply as needed to dissolve surface to depth of 4-5 thousandths. Apply solvent cement to fitting socket and pipe in amount greater than needed to fill gap. While both surfaces are wet, insert pipe into socket fitting with quarter turn to bottom of socket. Solvent cement application and insertion must be completed in less than 1 minute. Minimum of 2 installers is required on piping 4” and larger. Hold joint for 30 seconds or until set, whichever is longer. Reference manufacturer's recommendations for initial set time before handling and for full curing time before pressure testing.

3.5 TESTING

A. Refer to Testing paragraph of Section 220000 - General Plumbing Requirements.

B. Water test may be applied to system either in its entirety or in sections. Piping shall be tightly plugged and submitted to 10 ft head of water located at the most remote point of section being tested. Provide temporary test standpipe above most remote point being tested or extend system to obtain required 10 ft head of water. Head shall be maintained for at least 4 hours before inspection starts.

C. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials. No caulking of threaded joints or holes will be allowed.

D. Do not conceal pipe until successfully tested.

E. Testing with air will not be allowed.

END OF SECTION 221300

SECTION 222114 - PLUMBING SPECIALTIES

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 DESCRIPTION

A. This Section covers material specialties for piping systems.

1.3 SUBMITTALS

A. Manufacturer's technical data for the following:

1. Thermometers
2. Pressure gauges
3. Backflow preventers
4. Trap Primers
5. Flexible connections
6. Air vents

B. Shop drawings on items specified herein.

C. Certificates: Submit performance testing certificates for reduced pressure backflow preventers and double check backflow preventers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials herein specified shall be new unless otherwise noted.

2.2 THERMOMETERS

A. Units shall be socket mounted, digital, solar operated panel meters with lux rating of 10 with ABS plastic case and glass passivated thermistor.

B. Display shall be 3/8” LCD and shall be updated every 10 seconds. Unit shall have a minimum range of -40 to 300ºF, an accuracy of 1% of reading or 1ºF whichever is greater.

C. Unit shall operate in ambient temperature range of -30ºF through 140ºF, and humidity range of 0% to 100% non-condensing.

D. Provide thermometers with swivel mounting arrangement to permit up to 45 degrees rotation for easy reading.

E. Provide thermometers with extended necks as required for insulated piping.

2.3 PRESSURE GAUGES

A. Manufacturers: Marsh, Ashcroft, Marshalltown, Taylor, Trerice, U.S. Gauge and Weiss equal to Trerice number listed.

B. Pressure gauge shall be 4-1/2" die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge, Trerice Series No. 600. Provide with No. 301 Series maximum registering pointer.

C. Pressure gauges shall be calibrated for the following pressure ranges:

1. Water: 0 to 160 psi at 2 psi increments.
2. Compressed Air: 0 to 200 psi at 1 psi increments.

2.4 BACKFLOW PREVENTERS

A. Reduced Pressure Zone Backflow Preventers:

1. Manufacturers: Zurn/Wilkins, Febco, or Watts, equal to model listed
2. Bronze body, resilient check valve seats, shut-off valves, Y-pattern strainer with bronze body and stainless-steel screen, drain line air-gap fitting, bronze test cocks, certified in accordance with ASSE 1013 and AWWA C511.

B. Double Check with Vent (DCV) Backflow Preventers:

1. All brass construction with stainless steel trim, union connections, 175 psi pressure rating, 250°F temperature rating, and conforming to ASSE Standard 1012. Watts No. 9D Series.

C. In-line Double Check Backflow Preventers:

1. All bronze construction with stainless steel trim, union connections, 150 psi pressure rating, 140°F temperature rating equal to Watts No. LF7-R.

2.5 TRAP PRIMERS

A. Manufacturers: Precision Plumbing Products, Zurn, Sioux Chief

B. TP-1: Flow activated, with integral vacuum breaker.

C. TP-2: UL approved, electronic trap primer manifold, cabinet mounted; with 24 hr timer, vacuum breaker, solenoid valve and hydraulic shock arrestor. Control wiring shall be 120V single phase 3 wire connection for 120V solenoid and 24 hr timer. Box includes manual on/off switch and 5 amp fuse. Provide assembly without factory installed valve. Cabinet shall be 14" by 16" by 3-1/2" deep, 16 ga box with 14" x 16" hinged prime coated door.

2.6 FLEXIBLE CONNECTIONS

A. Bronze, braided flexible hose or neoprene twinsphere connectors by Mason Industries with 150 psi WOG working pressure rating.

B. Alternate manufacturers are Redflex, Resistoflex and Flexonics.

2.7 AIR VENTS

A. Manual Air Vents: Bell and Gossett Model 4V, 125 psi pressure at 210°F temperature, or approved equal. Use 1/2" ball valve for main pipes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide thermometers where indicated on drawings. Thermometers shall be easily read from floor or maintenance platforms. Calibrate thermometers to insure accuracy.

B. Install pressure gauges where indicated on drawings and as required from equipment manufacturers. Gauges shall be easily read from floor or maintenance platforms. Provide extensions as required to make gauges easily readable. Calibrate gauges to insure accuracy.

C. Install backflow preventers as indicated on drawings. Flush debris from strainers. Certified tester shall test reduced pressure zone backflow preventers to verify that functions are operational. Route the relief valve discharge line to exterior.

D. Access panels shall be provided where shutoff valves, air chambers, or other equipment is located in chases or other concealed spaces. They shall be fire rated where required and equipped with full piano hinge. Access panels shall be of sufficient size for maintenance of equipment and key lockable in public areas. Access doors shall be appropriately labeled to indicate systems and components at access door.

E. Install flexible connections for base mounted pumps and other vibrating equipment.

F. Install air vents at high points in water systems where air may collect.

END OF SECTION 222114

SECTION 223314 - WATER HEATING EQUIPMENT

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 QUALITY ASSURANCE

A. Water heating equipment shall conform to State and Local Codes, meet national standards, and be certified by respective organization and bear its stamp.

1.3 SUBMITTALS

A. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials specified herein shall be new unless otherwise noted.

2.2 COMMERCIAL HEAT PUMP WATER HEATER

A. Manufacturers: AO Smith, State Water Heaters, Lochinvar, or equal.

B. Water heater shall be heat pump and shall be capable of operating in efficiency, hybrid, or electric modes.

C. Unit shall be rated for 150 psig. working pressure, equipped with a commercial grade anode, all internal surfaces of the tank exposed to water shall be glass-lined, meets or exceeds the efficiency and standby loss requirements of the U.S Department of Energy and current edition of ASHRAE 118.1. The water heater tank shall have a minimum of 3-year limited tank warranty; the compressor, refrigeration components and all other parts shall have minimum one-year limited warranty. R-134a refrigerant, fully illustrated instruction manual.

D. Unit shall include the following:

1. Touch screen LCD display with built-in diagnostic and troubleshooting information
2. Electric elements with incoloy sheating,

E. Refer to Water Heater Schedule for water heater capacity required.

2.3 THERMAL EXPANSION TANK

A. Manufacturers: Amtrol, Goulds, Wessels or equal.

B. Expansion tank shall be precharged, diaphragm-type tank designed for hot water systems. Tank shall be ASME rated for 125 psig and come with replaceable rubber bladder, air charge fitting, steel base ring stand (floor mounted tanks only), factory primed, and enamel painted exterior, and ASME relief valve. Materials exposed to water to be NSF or FDA approved for potable water service.

C. Refer to Expansion Tank Schedule for basis of design and capacity required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water heaters as recommended by manufacturer. Provide final connections as required. Coordinate water heater location with other Contractors.

B. Initial startup and balancing service shall be provided by representative of manufacturer.

3.2 TRAINING

A. Provide training for Owner as follows:

1. Provide a program that covers overview, operator training, and maintenance training.
2. Operations training shall include:

   a. Start-up procedure
   b. Shutdown procedure
   c. Emergency operations
   d. Safety procedures and hazards
   e. Alarm conditions and actions
   f. Parameter adjustments
   g. Security

B. Provide a minimum of two separate, four-hour sessions, for a training class of approximately 10 people.

END OF SECTION 223314

SECTION 224000 - PLUMBING FIXTURES

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 DESCRIPTION

A. This Section lists plumbing fixtures and accessories including method of installation.

1.3 RELATED WORK

A. Section 221300 - Sanitary Waste and Storm Drainage Systems.

B. Section 221100 - Water Distribution System.

C. Section 123616 – Stainless Steel Countertop and Sink.

1.4 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

1.5 SUBMITTALS

A. One package of manufacturer's technical data for all items. Submittal shall be assembled brochure, showing cuts and full detailed descriptions for each item.

B. Shop drawings on items specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vitreous china fixtures shall be of highest quality, non-absorbent, hard-burned, and vitrified throughout.

B. Enameled ware shall be quality cast iron of uniform thickness and density, glazed to uniform depth and high gloss rubbed smooth, without chips or flaws, craze, or cracks, and completely acid resisting.

C. Stainless steel fixtures shall be 302/304 types of non-corrosive steel, 18 ga self rim for cabinet sinks, 14 ga for free standing compartment type sinks. Sink material shall have satin finish and cover corners, with faucet holes punched to match specified faucet fitting.

D. Insulation covers for traps and supplies shall be molded closed cell vinyl insulation and shall meet ASTM D635/E84 for flame and smoke spread. Insulation shall be vandal resistant and be color as listed.

E. Supplies shall be chrome plated heavy duty, sweat inlet by compression outlet ball valves with lockshield stops and escutcheon plates.

2.2 MANUFACTURERS

A. Water closets, urinals, and lavatories: Kohler, Zurn, American Standard, equal to number listed on drawing schedule.

B. Water Closet Seats: Bemis, Beneke, Church equal to number listed on drawing schedule.

C. Flush Valves: Zurn, Toto, Sloan equal to number listed on drawing schedule.

D. Stainless Steel Sinks: Tabco, Elkay or Just equal to number listed on drawing schedule.

E. Electric Water Coolers: Oasis, Haws, Halsey-Taylor, equal to model listed on drawing schedule.

F. Mop Basins (Janitor Sinks): Stern-Williams, Fiat or Zurn equal to number listed on drawing schedule.

G. Faucets: T & S, Zurn, Delta, Sloan equal to number listed

H. Fixture Traps: ProFlo, Zurn, McGuire equal to number listed on drawing schedule.

I. Insulated Traps and Supplies: Zurn, McGuire or True-Bro equal to model listed on drawing schedule.

J. Supplies and Stops: ProFlo, Zurn, McGuire equal to number listed.

K. Hose Bibbs: Delta, Zurn, or Watts equal to number listed on drawing schedule.

L. Wall Box: Acorn, Guy-Grey or Watts equal to number listed on drawing schedule.

M. Wall Hydrants: Smith, Wade, Watts, Woodford, or Zurn equal to number listed on drawing schedule.

2.3 CARRIERS AND SUPPORTS

A. Carrier manufacturers shall be Josam, J.R. Smith, or Zurn, as outlined herein, with models suitable to fixture and use intended. Provide carriers with adjustable faceplate, rectangular steel uprights and at least 3 bolt lugs for securing carrier to floor. Adjustable water closet carriers shall be either right or left, single or double, horizontal or vertical as suggested by drawings and riser diagrams.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures as recommended by manufacturer. Caulk around fixtures mounted on irregular surfaces such as tile or stone with sealant as specified in division 07.

B. Support fixtures with proper carrier for each use. Insure that carrier is solidly anchored to prevent rocking whatever piping is used. Anchor bolts in carrier foot shall extend 3" minimum into concrete slab.

C. Fixture carriers shall be suitable for securing each plumbing fixture in place solidly, yet allowing its removal when necessary. Carriers shall be capable of mounting "Barrier Free" fixtures at suitable heights.

D. Install each fixture with a one-piece removable smooth trap for servicing and cleaning. Install fixture stops in readily accessible location for servicing.

E. Install barrier free fixtures in compliance with NC State Building Code and Federal ADA Accessibility Guidelines. Install barrier free lavatory traps parallel and adjacent to wall and supplies and stops elevated to 27" above finished floor to avoid contact by wheelchair users.

F. Return fixture waste and supply piping into wall as high as practicable under fixture. Provide accessible shutoff in fixture supply. Protect "barrier free" supply and drain piping with white colored wrap neatly trimmed to prevent contact with hot or sharp surfaces by user.

G. Provide individual supplies to fixtures and rough-in fixture piping with adequate support to prevent movement fore, aft and laterally. Provide additional blocking as required.

H. Install flush valves for barrier-free water closets with operator handle facing wide side of toilet stall.

I. Provide unions at water connections to drinking fountains and electric water coolers.

J. Wiring from sensor operated fixtures to electrical supply shall be neat, adequately supported, concealed from public view and compliant with manufacturer's written instructions and Division 26 requirements.

3.2 PROTECTION

A. Protect finished surfaces of fixtures from accidental damage or discoloration by use of protective covering.

3.3 CLEANING

A. Prior to Owner acceptance, clean fixtures with compounds recommended by manufacturer, and remove stains and marks from surrounding walls and countertops.

END OF SECTION 224000

SECTION 230000 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Intent of drawings and specifications is to obtain complete systems, tested, adjusted, and ready for operation.

B. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

C. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

D. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions. Dimensional data for equipment shall be based on approved submittal data.

E. Where architectural features govern location of work, refer to architectural drawings prior to fabrication of materials or system components. Refer to structural drawings to familiarize with structural constraints including structural member sizes, framing details, opening sizes, shear walls, and miscellaneous details which may impact the work. Failure to coordinate with the work of other Trades which requires relocation of installed work to coordinate with architectural or structural details shall not be allowed as a basis for extra compensation by the contractor.

F. Contractor may install additional piping, fittings and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Designer.

1.2 RELATED WORK

A. Concrete Work:

1. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of mechanical equipment.

B. Painting:

1. Furnish equipment with factory applied prime finish unless otherwise specified.
2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Designer.
3. Furnish one quart sized can of touch up paint for each factory finish which will be final finished surface of product.
4. Painting of exposed mechanical ductwork/piping is specified in Division 09. Coordinate labeling of mechanical items specified to be painted. Refer to Section 230553 – Mechanical Systems Identification for additional requirements.

C. Firestopping Penetrations:

1. Refer to Division 07 for firestopping requirements.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State, and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.4 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1. AABC Associated Air Balance Council
2. ACG AABC Commissioning Group
3. ACCA Air Conditioning Contractors of America
4. ADC Air Diffusion Council
5. AGA American Gas Association
6. AMCA Air Movement and Control Association
7. ANSI American National Standards Institute
8. ARI Air-Conditioning and Refrigeration Institute
9. ASHRAE American Society of Heating Refrigerating & Air Conditioning Engineers
10. ASME American Society of Mechanical Engineers
11. ASTM American Society for Testing and Materials
12. AWS American Welding Society
13. AWWA American Water Works Association
14. FM Factory Mutual Engineering
15. FS Federal Specifications
16. IEEE Institute of Electrical and Electronics Engineers
17. IRI Industrial Risk Insurers
18. MCA Mechanical Contractors Association
19. MSS Manufacturers Standardization Society
20. NEBB National Environmental Balancing Bureau
21. NEC National Electrical Code
22. NEMA National Electrical Manufacturers Association
23. NFPA National Fire Protection Association
24. NIST National Institute of Standards & Technology
25. NSF National Sanitation Foundation
26. OSHA Occupational Safety and Health Standards
27. PDI Plumbing and Drainage Institute
28. SMACNA Sheet Metal and Air Conditioning Contractors National Association
29. UL Underwriters Laboratories, Inc.
30. All work shall also comply with the latest edition of the North Carolina State Building Codes.

1.5 SUBMITTALS

A. Shop Drawings (Product Data):

1. Electronic submittals shall have Bookmarks identifying all of the major sections.
2. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
3. Mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product on drawings. Cross off all extraneous data which does not pertain to submitted equipment and circle all applicable options.
4. Contractor shall clearly indicate on submittals any deviations from project specifications. Approval granted on shop drawings shall not relieve the Contractor of their responsibility to construct the work in accordance with the Contract Documents and specifications.

5. When manufacturer's reference numbers are different from those specified, provide correct cross reference numbers for each item. Submittals shall be clearly marked and noted accordingly.
6. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include all required components.
7. Submittals of electrically powered equipment and devices shall include composite wiring diagrams, motor efficiency and power factor data. Submitted wiring diagrams shall be customized to reflect actual project conditions.
8. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
9. Submittals which are not complete, not properly marked, or not properly checked by Contractor will be returned without review.
10. Provide equipment performance curves on all applicable equipment. All submitted performance curves for fans, pumps, airflow monitoring stations (AFMS), circuit setters, miscellaneous flow devices, etc., shall be printed legibly on a full size 8-1/2 x 11 page, be clearly marked with the specified design “duty point”, and be provided with sufficient horizontal / vertical axis detail (including units of operating parameters) to be readily used as a troubleshooting tool in the field by the TAB contractor, Cx Authority, engineer of record (EOR), etc.

B. Operation and Maintenance Manuals:

1. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system. Include table of contents in each volume where multiple volumes are submitted.
2. Manuals shall include the following:

   a. Copies of all approved shop drawings. Shop drawings shall include record of Designer’s review.
   b. Manufacturer's operating and maintenance instructions. Include parts lists of all items or equipment with component exploded views with part numbers. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
   c. CD ROM’s of O&M data with exploded parts lists where available.
   d. Phone numbers and addresses of local parts suppliers and service companies.
   e. Internet/WEB page addresses where applicable.
   f. Wiring diagrams.
   g. Startup and shutdown procedures.
   h. Composite electrical diagrams.
   i. Flow diagrams for each system identified on Contract Documents with final operating setpoints indicated for all control devices.
   j. Lubrication instructions.
   k. Factory and field test records. (Refer to Test and Balancing in Part 3 of this Section).
   l. Final approved air and water balance reports.
   m. Ductwork leakage test reports. Tests reports shall include record of Designer’s review.
   n. Piping pressure test reports. Test reports shall include record of Designer’s review.
   o. Valve identification charts as specified in Section 230553 – Mechanical Systems Identification.
   p. Access panel identification charts as specified in Section 230553 – Mechanical Systems Identification.
   q. Preventative maintenance requirements and schedules for all major equipment.
   r. Schedule of all air filters in HVAC equipment (including but not limited to AHUs, FCUs, ACUs, etc.) identifying equipment name and location, filter count, type, size, MERV rating, and initial air pressure resistance (in.wg) at 500 fpm face velocity.
   s. Warranty information. Extended warranty contact information. Registration of extended warranty on behalf of NC State and information required for extended warranty.
   t. Additional information, diagrams, or explanations as designated under respective equipment or systems specification sections.

3. The O&M manuals shall include the final submitted & approved engineering performance data for all mechanical equipment, including but not limited to the following: airflows; static pressures; ΔP data; entering & leaving dry bulb & wet bulb temperatures; waterflows; total dynamic head; entering and leaving water temperatures; volts / phase; amps; power consumption (brake horsepower / kW) at full load (and part load, where applicable); sound power level; vibration level (displacement & velocity); VFD minimum operating frequency; etc. The O&M manuals shall include the engineering performance curves for all applicable mechanical and electrical equipment, including but not limited to the following: fan curves; pump curves; terminal box ΔP versus airflow curves; circuit setter / auto-flow device ΔP versus waterflow curves; AFMS ΔP versus airflow curves; motor % load versus efficiency curves; power consumption versus load curves; fuel consumption versus load curves; etc. Equipment items specifically included are all air handling unit fans (AHU), mini-split unit fans (AC), chilled water (CHW) / hot water (HW) fan coil units (FCU), VAV terminal units (AT), general exhaust fans (EF), and pumps.

1.6 JOB CONDITIONS

A. Electrical Coordination:

1. Provide all motors and all electrically powered or electrically controlled equipment.
2. Provide all relays, actuators, timers, alternators, pressure, vacuum, float, flow, aquastats, freezestats, line and low voltage thermostats, remote selector switches, remote push-button stations, emergency break glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with mechanical equipment. Provide starters, disconnects, and associated wire and conduit serving motors or mechanical equipment and coordinated with Division 26 requirements.
3. Provide motor starters for mechanical equipment. Power wiring to a termination point consisting of a junction box, trough, or disconnect switch and line side terminations are specified in Division 26. Provide wiring from the termination point to the mechanical equipment, including final connections.
4. Motor starters and disconnects for exterior applications and within air handling units shall be NEMA 3R. Motor starters and disconnects for interior applications shall be NEMA 1.
5. Provide all wiring required for controls and instrumentation not indicated on the drawings. This shall include providing 24V or 120V power to air terminal devices and any stepdown transformers and disconnect switches required. Coordinate with Electrical Contractor for location of 120 volt circuits for controls circuits. These circuits are located in the electrical room on each floor of the building. All controls circuits for equipment connected to the emergency generator shall be fed from power circuits which are also connected to the emergency generator. Refer to 230901 Control Systems Integration.
6. Electrical drawings and/or specification show number and horsepower rating of motors furnished under this Division, together with their actuating devices. Immediately notify of any change in size, HP rating or means of control made to any motor or other electrical equipment. Additional costs due to these changes shall be under this Division.
7. Power wiring and motor control wiring are indicated on Electrical contract documents. Connect all equipment complete and ready to operate.
8. Contractor shall be responsible for all wiring associated with equipment under this contract, except wiring which is scheduled to be by others.
9. Wiring done by contractor shall be in accordance with Division 26 requirements and applicable electrical codes.
10. Furnish wiring diagrams to Contractor for apparatus indicating external connection and internal controls.
11. All standard manufactured items or custom fabricated assemblies of electrically operated equipment shall be listed and labeled by a nationally recognized testing laboratory, such as Underwriter's Laboratory, Inc. (UL).

12. Disconnect devices provided under Division 23 shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings. The equipment electrical connection points shall be labeled with listed electrical short circuit current rating (SCCR). The SCCR shall not be less than interrupting rating of upstream overcurrent device as shown on electrical drawings. SCCR shall be marked on equipment control enclosure in accordance with UL508 or other acceptable accredited third party testing agency standard.
13. Motors shall be selected such that the rated brake horsepower does not exceed 85% of the nameplate horsepower.

B. Cutting and Patching:

1. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore all work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components due to interferences encountered in the field.
2. Provide all materials required for patching unless otherwise noted.
3. Do not pierce beams or columns. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening. Coordinate with Designer for approval of all core drilled openings prior to commencing with work.
4. Coordinate ductwork/piping openings through CMU or concrete walls to minimize quantity of penetrations. Refer to structural plans for lintel details, control joints, bond beam details, etc., and dimension all openings through CMU or concrete walls on Coordination Drawings.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

PART 2 - PRODUCTS

2.1 ESCUTECHEONS

A. Polished stainless steel, hinged, split-ring escutcheon, with set screw. Split type escutcheons are not allowed.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall closely coordinate with all other contractors and subcontractors on this project. Prior to installing any piping, ductwork, conduit, equipment, etc, it is Contractor's responsibility to coordinate work with other Contractors and to install systems in accordance with the Coordination Drawings. Failing to do so will not relieve Contractor from the responsibility of relocating installed piping, ductwork, conduit, equipment, etc to accommodate the work of other Contractors and required maintenance space if so required and directed by the Designer/Owner.

B. Verify elevations and measurements with architectural and structural plans prior to fabrication or installation of materials.

3.2 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Store and handle all material in compliance with the manufacturer's recommendations to prevent their deterioration and damage.

B. Store all materials in the original containers or bundles with labels informing about manufacturer, product name, and any potential damages.

C. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions.

E. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

F. Protect openings in equipment until connected to system to prevent entry of foreign materials.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Penetrations through fire-resistance-rated floors, roofs, walls and partitions including openings containing pipes, ducts and other penetrating items shall comply with the requirements of specification section "Firestopping". Avoid multiple penetrations of common fire barrier openings. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

B. Coordinate size and location of openings, chases, and furred spaces with appropriate contractors prior to submission for approval of steel and precast shop drawings. Provide during progress of construction all sleeves and inserts that are to be built into structure.

C. Temporary sleeves, if used to form openings, shall be removed prior to installation of permanent materials. Permanent sleeves shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

D. Steel sleeves, when required, shall be Schedule 40 galvanized, welded steel pipe ASTM A53 Grade A with integral water stop.

E. Pipe sleeves smaller than 6-inches shall be steel; pipe sleeves 6-inches and larger shall be 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.

F. For core drilled holes, size and location shall be reviewed and approved by Designer prior to execution.

G. Submit product data and installation details for all penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.

H. Openings for pipe shall be minimum 1" larger in diameter than pipe, or where fire resistant penetrations are required, sized in accordance with recommendations of firestopping systems manufacturer.

I. Openings for insulated piping shall be sized based on outside diameter of insulation when it is specified or detailed to be continuous through opening.

J. Openings for duct penetrations shall be no more than ¼" larger on all sides than size of openings for duct or duct including insulation, if applicable. Openings for ducts with fire or combination fire/smoke dampers shall be in accordance with manufacturer's damper installation requirements.

K. Seal non-rated wall openings with acoustical joint sealant as specified in specification section 07 – Joint Sealants.

L. Where penetrations occur through exterior walls into building spaces or into structures requiring a water tight seal, use steel pipe sleeves with integral water stop plate continuously welded on both sides. Sleeves shall have hot dip galvanized or primer paint finish. Seal annular space between sleeves and pipe with modular wall and casing seals or sealing system by another manufacturer approved by the Designer. Seal shall be modular, mechanical type consisting of inter-locking rubber links shaped to continuously fill the annular space between pipe and pipe sleeve. Links shall be sized and selected per manufacturer's recommendations and shall be rated for -40°F to 250°F service for all systems with operating temperatures below 150°F and -67°F to 400°F for all systems with operating temperatures above 150°F. Where casing seals are used with insulated pipe, insulation shall be butted against seals on both sides. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

M. Finish and trim penetrations as shown on details and as specified hereinafter.

N. Provide chrome or nickel plated escutcheons where piping passes through walls, floors or ceilings and is exposed in finished areas. Size escutcheons to fit pipe and pipe covering for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitors closets, storage rooms, etc., unless suspended ceilings are specified.

O. Trim duct penetrations exposed in finished areas with 2" wide galvanized or aluminum trim collars properly sized to fit duct. Collars shall be same gauge as duct, prime finish unless noted otherwise. Finished areas shall not include mechanical rooms, janitors closets, storage rooms, etc., unless suspended ceilings are specified.

P. Duct/pipe/conduit penetrations through floor slab of attic shall have water stopped curb surrounding pipe/duct/conduit opening. Coordinate with Construction Manager to verify locations of openings based on Coordination Drawings. Refer to structural plans for preliminary location of openings for purposes of coordination.

Q. In spaces designated to be pressure-balanced (i.e. Special Collections archive and SC Shell), cut and patch all openings in walls and ceilings resulting from ducts, pipe, and conduit to within ¼" of penetrating system and seal opening with approved sealant. Do not use escutcheon plates in these rooms.

1. Exposed conduit penetrations shall be sealed as follows:

   a. Seal openings around conduit and patch work with sprayable, flexible, liquid polyvinyl chloride coating equal to Andek "Cocoon 72634-USDA". Sealant to be installed per manufacturer's application requirements.

2. Penetrations other than conduits (junction boxes, light fixtures, duct, pipe, etc.) including wiring devices shall be sealed as follows:

   a. Seal non-rated opening with silicone sealant
   b. Refer to Division 26 drawings and specifications for specific details for electrical components.
   c. Confirm selected sealant is compatible with paint provided by others prior to application.
   d. Product: One-part Mildew Resistant Silicone Sealant: Type S, Grade NS, Class 25, Uses NT, G, A, and as applicable to nonporous joint substances indicated O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:

      1) 786 Mildew Resistant Silicone Sealant; Dow Corning Corp.
      2) Sanitary 1700 Silicone Sealant; General Electric Co.
      3) 898 Silicone Sanitary Sealant; Pecora Corp.
      4) Tremsil 600; Tremco Corp.
      5) OmniPlus; Sonneborn Building Products Div, Rexnord Chemical Products, Inc.

3.4 EQUIPMENT SHUTOFF VALVES

A. Provide shutoff valves at each piece of equipment connecting to piping system and elsewhere as shown or specified. Refer to Section 23 2118 – Valves for requirements of valve type.

3.5 EQUIPMENT ACCESS

A. Install piping, conduit, ductwork and accessories to permit access to equipment for maintenance. Relocation of piping, equipment, ductwork or accessories as required to provide acceptable access, as determined by Owner, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other equipment being installed or already in place.

C. Access doors in walls, chases, or above inaccessible ceilings will be provided under Division 08, unless otherwise indicated. Access doors for valves, fire, smoke and combination fire/smoke dampers, control dampers, smoke detectors, airflow meters, fans, coils, reheat coils, unions, dampers or other equipment/devices requiring access for servicing, repairs or maintenance located in walls, chases or above inaccessible ceilings, unless otherwise noted or other equipment shall provide access for service, repairs, and/or maintenance. Provide necessary coordination information to include required locations, sizes, and rough-in dimensions. Access doors used in fire rated construction shall have UL label. During preparation of Coordination Drawings, Contractor shall review architectural reflected ceiling plans for areas with inaccessible ceilings. Preference shall be given to avoid layout of systems and equipment which will require access space over inaccessible ceilings as much as possible. If access panels are unavoidable, Contractor shall clearly locate access panels on Coordination Drawings for review by Designer. All costs for additional access doors beyond what is shown on architectural plans are this Contractor's responsibility.

3.6 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, and supports. This work shall also include but is not limited to providing supplemental steel attached to building structural members to allow for pipe and duct hangers to maintain specified maximum hanger spacing distances.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or piping from metal roof decking.

3.7 EQUIPMENT GUARDS

A. Provide equipment guards over belt driven assemblies, pump shafts, exposed fans and elsewhere as indicated in this specification or required by Code.

B. Paint all equipment guards bright yellow.

C. All belt guards, including those factory made, shall be ventilated and comply with OSHA requirements.

3.8 SUPPORT PROTECTION

A. Guard equipment in occupied areas, mechanical rooms, attic, and any areas requiring normal maintenance access where piping/ductwork/equipment is exposed to protect personnel from injury.

B. Provide minimum 1/2" thick closed cell elastomeric thermal insulation (Type A insulation as referenced in Section 230700) applied with adhesive on lower edges of equipment and mechanical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.9 START-UP AND TEMPORARY CONDITIONING

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This shall include "Owner-furnished, Contractor-installed" (OFCI) as well as "Contractor-furnished, Contractor-installed" (CFCI) systems and equipment. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures. Contractor shall provide services of technician/mechanic knowledgeable in start-up and check-out of types of systems and equipment on project. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel. Coordinate start-up with Construction Manager, Designer, Commissioning Agent and all trades.

1. Develop and submit to the owner, EOR and Commissioning Authority (CxA), for review and comment, a complete START-UP AND INITIAL CHECK-OUT PLAN. Startup plan shall utilize prefunctional startup checklists (PFCs) from the CxA's PRELIMINARY Cx PLAN, and manufacturer's start-up procedures and shall be utilized on all systems / equipment undergoing commissioning (Cx) / Functional Performance Testing (FPT) procedures. The Start-up and initial check-out 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.
2. Prepare a preliminary schedule for commissioning activities, including piping system pressure and leakage testing, flushing and cleaning, ductwork air leakage testing (DALT) and cleaning, equipment start-up, and testing, adjusting and balancing (TAB) start and completion, and update the schedule during the construction period, as required. Please note that chilled water (CHW), reheat hot water (HW) and heating / domestic hot water (DHW) systems shall not be started-up until hydrostatic pressure testing, system leak identification and repair, cleaning, flushing, and pre-treatment have been completed to the satisfaction of the engineer of record (EOR) and the water treatment contractor. In addition, do not install ductwork insulation until after ductwork air leakage testing (DALT), system leak identification and repair and cleaning have been completed and the test results submitted to the EOR. Contractor shall notify the owner, EOR and CxA immediately if the implementation of any of the aforementioned activities has been delayed.
3. Four weeks prior to the start-up of any Division 23 equipment, schedule equipment and systems start-up and check-out and notify the owner, EOR and CxA in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Division 23 subcontractor, in accordance with manufacturer's published procedures. The EOR and CxA shall be notified in writing by the Division 23 subcontractor when the various equipment startups occur, so that they have the option of witnessing the startup procedures, if they opt to do so.
4. Conduct equipment start-up and initial check-out and submit filled-out & signed PFC forms on all equipment installed under DIVISION 23 to the EOR and CxA for their review, information and reference, prior to the start of any TAB fieldwork on any system / equipment. If aforementioned equipment was started up by a factory service technician, then copies of the service technician's startup checklists shall be submitted along with the PFC forms. Review prefunctional testing documentation, prior to submittal, to ensure that there is written documentation that each of the manufacturer-recommended startup procedures has been completed.
5. Completed start-up, check-out, and prefunctional test forms shall be submitted to the EOR and CxA for their review prior to the start of Acceptance Phase Cx / FPT procedures. The submitted PFC forms shall list any deficiency items encountered prior to the final successful startup of the equipment, which have subsequently been corrected, at the bottom of the procedures form or on an attached sheet. The Division 23 subcontractor shall have corrected all deficiencies encountered during equipment prefunctional testing, prior to submitting the final prefunctional checklist forms.

6. Once starting of mechanical systems begins, the mechanical contractor shall maintain an appropriate maintenance log, where applicable, of all interim maintenance tasks performed on all started-up equipment, so that manufacturer's warranties are not voided prior to the equipment being turned over to the owner. This log shall be submitted when the equipment is officially released to the owner, as part of the O & M manual. In addition, provide complete water treatment information, and appropriate water treatment log for all hydronic and steam systems operated prior to date of substantial completion.
7. The GC / Division 23 Subcontractors shall compile and prepare documentation obtained during all prefunctional testing and all Cx / FPT procedures and submit copies of this information to the CxA, as well as including it the Division 23 subcontractor's O & M manual submittal, prior to beginning the training of the Owner's personnel. The documentation provided for the Division 23 O & M manual shall also include the subcontractor's maintenance log compiled in maintaining all started-up equipment, as described in paragraph 3.9.A.6 above.

B. Where any systems including but not limited to air handling units shall be requested to be started and operated before completion of construction for temporary conditioning, Contractor shall submit a Temporary Conditioning Plan for Owner and Designer review and approval. This Temporary Conditioning Plan is a required element of the Construction IAQ Management Plan. No systems shall be started during the construction period without approval of the Temporary Conditioning Plan. The temporary conditioning plan shall include the following minimum requirements:

1. Verify all start-up documentation will be completed same as for final start-up.
2. Contractor to address how equipment and systems will be maintained in good, clean condition. Document steps to return systems to as new condition prior to turnover to Owner.
3. Describe how temporary filtration covering (MERV-8 minimum) will be provided over grilles used for air movement and plastic covers to be used on all other open ducts during construction. Note how filters will be monitored and replaced during construction to protect from dust entry.
4. Describe lubrication and maintenance procedures to be performed on equipment including maintenance logs to be utilized.
5. Describe use of temporary construction strainers on water systems following flushing of systems.
6. Provide description of how systems will be controlled (automatically or manually) and target temperature /humidity setpoints during construction for various finishing activities. Describe interface with life safety systems.
7. Describe how building will be sealed to prevent humidity conditions that could promote mold growth.
8. Describe how systems will be segregated when only a portion of the system will be used.

C. Any material, device, component, or equipment that is assessed to have been damaged or have a substantially shortened life as a result of use during construction shall be replaced by the Contractor at no cost to the Owner or project.

3.10 LUBRICATION

A. Upon completion of work and before turning over to Owner, clean and lubricate bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by manufacturer.

B. Contractor is responsible to maintain lubrication of all mechanical equipment under his contract until Owner accepts work. This shall include periodic rotation of fan wheels to prevent premature bearing failures.

3.11 CLEANING

A. After installation is complete, clean all systems to "as-new" condition (inside and outside).

B. Clean equipment and surfaces of work installed by others when soiled to "as-new" condition.

C. Repair or replace any equipment or surface of work which is damaged.

D. Clean piping and ductwork both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping or ductwork are rusted, clean and restore surface to original condition. Contractor shall provide written confirmation that interior ductwork surfaces are clean prior to Owner turnover. If Owner has any doubts as to the cleanliness of the duct systems, Owner reserves the right to use any method to inspect the duct. If duct systems are found to have dirt or other foreign matter on interior surface, the contractor shall be responsible for all costs required to restore ductwork to as-new condition to the satisfaction of the Owner.

E. Clean pipeline strainers to restore them to original condition or replace with new strainer elements. Remove temporary start-up strainer screens and replace with permanent strainer screens.

F. Clean all equipment as recommended by manufacturer.

G. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

H. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

I. Replace throwaway or replaceable media air filters used during the construction period with new filters after construction has been completed and before building is air balanced. Filter replacements shall be as hereinafter specified.

J. Dirt, plaster dust and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, register, and grilles.

K. Repair or replace any equipment or surface of work which is damaged to the full satisfaction of the Owner and the Designer.

3.12 ATTIC STOCK

A. AHU-1,2 UV Lamps

1. Provide one (1) full spare set of UV Lamps for both AHUs. Refer to Package A 237313.

B. AHU-1,2 Motors

1. Base bid: No attic stock.
2. Alternate Bid No. 42: Provide one (1) spare motor for each motor type. Refer to Package A 237313.

C. HVAC VFDs

1. Base bid: No attic stock.
2. Alternate Bid No. 43: Provide one (1) spare VFD of each size and one (1) spare keypad. Refer to Package A 230515.

D. AHU-3,4 and CU-3,4 Motors

1. Base bid: No attic stock.
2. Alternate Bid No. 44: Provide one (1) spare motor for each motor type. Refer to Package A 238126.

END OF SECTION 230000

SECTION 230528 - MECHANICAL SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all supporting devices as specified and as required for proper support of piping, ductwork, equipment, materials and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.

1.2 SUBMITTALS

A. Shop drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:

1. Manufacturer's name
2. Model numbers
3. Materials of construction and load ratings (lbs)
4. Schedule of hangers and support devices with pipe support spacing
5. Insulated pipe supports along with application chart or table
6. Insulation protection saddles and weight bearing insulation table
7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
8. Structural attachments, inserts and concrete anchors
9. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
10. Equipment mounting devices
11. Pipe guides and anchors
12. All other appropriate data

1.3 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME Code for Pressure Piping B31.1 and MSS Standard Practice SP-58 (Materials, design and Manufacture), SP-69 (Selection and Application), and SP-89 (Fabrication and Installation Practices), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Support devices shall be factory fabricated by manufacturers and have published load ratings.

D. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

E. At anchors to concrete slab on metal decking: When loading exceeds the limits and criteria indicated on the Structural Drawings, provide Delegated Design by the installing contractor's Structural Engineer for the proposed condition.

F. Determine maximum deflection using the following equation:

D = (H or L)/250

Where: D = Maximum deflection in inches
H = Member height in inches
L = Member length in inches

G. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard primed, galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application. Coat cut edges, welds or any damaged finish with galvanized paint.

H. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable. Use of field applied materials such as tape and other materials of a temporary nature are not allowed as a means of complying with dielectric separation requirements.

I. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be steel with either galvanized finish or paint finish. Paint type shall be approved by Designer.

J. Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe.

K. In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports within the room of the source equipment. Refer to Division 23 Section Vibration Isolation.

L. Piping connected to coils which are in assembly mounted on vibration isolators shall have flexible piping connections and vibration supports as indicated above. Piping connected to coils which are in equipment where fan assembly is separately isolated by means of vibration isolators and duct flexible connections does not require additional spring vibration supports. Flexible connections and vibration isolators are specified in Division 23 Section Vibration Isolation.

M. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

N. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

O. Punching, drilling, or welding of building structural steel is not allowed unless approved by Designer.

P. Application of concrete inserts and concrete anchors shall be reviewed and approved by Designer prior to installation.

Q. Any proposed weld attachments to building structure shall be reviewed by Designer prior to execution of work. This review may result in use of other welding codes or standards, which may apply to "structural work".

R. Do not support equipment or piping from metal roof decking.

PART 2 - PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspend piping/ductwork/equipment from ceilings or walls or within shafts and as required for floor supported equipment.

2.2 PIPE HANGERS AND SUPPORTS

A. Manufacturers: Anvil, nVent, TOLCO, Carpenter & Paterson, PHD, NPHC or B-Line, equal to Anvil figures listed. Corresponding MSS type is indicated where applicable.

B. Hangers/supports for copper pipe where supports directly contact to pipe, shall be either copper plated or PVC coated.

C. For insulated pipe supports, refer to Insulated Pipe Supports in Part 2 and Part 3 of this Section.

D. Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (90°F and above)	2" and smaller	65 (MSS Type-1) 260 (MSS Type-1)	---
	2-1/2" to 6"	---	171 (MSS Type-41) 181 (MSS Type-43)
	8" and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (65°F to 89°F)	2" and smaller	65 (MSS Type-1) 260 (MSS Type-1)	---
	2-1/2" and larger	260 (MSS Type-1) 216 (MSS Type-4)	---
Cold Pipes with Insulation (33°F to 64°F)	2" and smaller	65 (MSS Type-1) 260 (MSS Type-1)	---
	2-1/2" and larger	260 (MSS Type-1) 295 (MSS Type-1)	---

1. For pipe size 2-1/2" and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 may be used if vertical angle of hanger rod is less than 4 degrees.

E. Flat Surfaces (Trapeze, Rack Type):

1. Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with Insulation (90°F and above)	2" and smaller	Klo-Shure	---	---
	2-1/2" and larger	---	171 (MSS Type-41) 177 (MSS Type-41) 271 (MSS Type-45) 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60° to 89°F)	all sizes	1008-1018	---	---
Ambient Bare (Copper) pipes (65° to 89°F)	all sizes	1008-1018	---	---
Cold Pipes with Insulation (33°F to 64°F)	10" and smaller	137 (MSS Type-24)	---	---
	12" and larger	432	171 (MSS Type-41) 177 (MSS Type-41) 271 (MSS Type-45) 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement.

2.3 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167 (MSS Type 40) constructed of galvanized carbon steel. Select shield to accommodate outer diameter of insulation. Shield length and gauge shall be as follows.

Pipe Size	Length	Gauge
1/4" thru 3"	12"	18
4" thru 6"	18"	16
8" thru 14"	24"	14

B. For PP-R piping, provide shield compatible with manufacturers recommendations

2.4 INSULATION PROTECTION SADDLES

A. Anvil Fig. 160 series (MSS Type 39), constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified in Section 230700 - Mechanical Systems Insulation.

B. For PP-R piping, provide saddle compatible with manufacturers recommendations

2.5 WEIGHT BEARING INSULATION INSERTS

A. Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.

B. Minimum length of inserts shall be 12" or 2" longer than insulation protection shields, whichever is longer. Quantity and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.

C. Hot Pipes (90°F and above):

1. High-density calcium silicate insulation (Type H insulation as referenced in Division 23 Section Mechanical Systems Insulation) similar to Johns Manville Thermo-12 or cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas. Maximum compression strength for load calculation shall be 100 psi.
2. HAMFAB H-Block by ICA Inc. may be used. Maximum compression strength for load calculation shall be 30 psi.

D. Cold Pipes (64°F and below):

1. Cellular glass insulation (Type G insulation as referenced in Division 23 Section Mechanical Systems Insulation) similar to Pittsburgh Corning Foamglas, maximum compression strength 100 psi, Koolphen K insulation by Kooltherm Insulation, 5 lb./ft3, maximum compression strength 50 psi, or HAMFAB H-Block by ICA Inc., maximum compression strength 30 psi. H-Block inserts shall be coated with vapor barrier coating similar to CADALAR 670 by SKIRGES Corp.
2. SNAPP ITZ pre-insulated pipe supports by Mechanical Pipe Shields Mfg or Tru-Balance Insulated Saddles by Buckaroos Inc. may be used. Pre-insulated pipe supports shall use polyisocyanurate (Trymer 2000 or 4000 or Insul-Phen insulation), with PVC jacket and G90 galvanized steel shield.

E. Refrigerant pipes and other systems utilizing elastomeric insulation:

1. Aerofix-U (or equal) closed cell, lightweight polymeric ridged, high-compressive strength foam insulation pipe support with anti-abrasion surface for contact with piping material. Components shall be UV and weather resistant and be rated to work from -70F to 250F. U-value requirements shall match adjacent insulation.

F. Insulated ductwork:

1. Phenolic insulation (Type PP insulation as referenced in Section 230700).

2.6 PRE-INSULATED PIPE SUPPORTS

A. Type C Insulated Pipe Supports (Heavy Duty):

1. Manufacturers:

a. Pipe Shields, Inc., Bergen Pipe Supports, or Rilco equal to Pipe Shields models listed.
b. Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Pipe Shields, Inc.

1) Pipe supported on hangers: Model “A” Series and Model “D” Series

2) Pipe supported on flat surfaces and pipe rollers: Models “A” Series
3) Pipe supported on slides: Model "B" Series with lateral guide or restraint
4) Pipe anchors: Model “C” Series
5) Riser clamps: Model “E” Series with thrust plates. Select proper model for restraint for downward load or upward load.

B. Contractor may propose to utilize contractor-fabricated insulated pipe supports in lieu of manufactured Type C Supports. Use of contractor-fabricated assemblies is subject to approval of appropriate submittal data. Submit detail drawings of assemblies and product data showing equivalency to specified manufactured products for approval.

1. Description:

a. Load-rated assembly consisting of high compressive strength insulation material completely encircling circumference of pipe, vapor barrier jacket system incorporating structural inserts and insulation protection shield/casing where applicable.

2. Insulation Material:

a. Water-resistant high density calcium silicate with minimum density of 13 lb/ft3 and compressive strength not less than 100 psi. Thermal conductivity shall be not more than 0.38 Btu·in/(hr·ft2·°F) at 75°F.
b. Structural Inserts:

1) Structural inserts used by manufacturer to reinforce between pipe and insulation jacket for clamping devices shall be water-resistant high compressive strength inorganic materials selected by manufacturer for desired combination of structural strength and insulating properties. Structural inserts shall have minimum compressive strength of 600 psi. Thermal conductivity shall be not more than 0.58 Btu·in/(hr·ft^2·°F) at 75°F.

c. Jacket:

1) Jacket shall consist of G90 galvanized steel conforming to ASTM A-653 and shall provide complete vapor barrier around insulation and bearing surface for protection of insulation.
2) When recommended by manufacturer, use reinforced insulation protection shield at support bearing surface. Insulation shall extend 1” beyond insulation protection shield to maintain vapor barrier integrity.

2.7 HANGER RODS

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rods to be continuous length. Use of short sections of rods with couplings shall not be permitted. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size With Single Rod	Rod Diameter (inches)	Maximum Load (lbs.) of Hanger Rod (Not exceeding 650°F Service Temp.)
2"	3/8	730
3"	1/2	1350
5"	5/8	2160

Max. Pipe Size With Single Rod	Rod Diameter (inches)	Maximum Load (lbs.) of Hanger Rod (Not exceeding 650°F Service Temp.)
8"	3/4	3230
12"	7/8	4480

2.8 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish.

2.9 ROD ATTACHMENTS

A. Anvil Fig. 290 (MSS Type-17), galvanized finish.

2.10 U-BOLTS

A. Anvil Fig. 137 (MSS Type-24), galvanized finish.

2.11 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 218 (MSS Type-30), 228 (MSS Type-28 or 29) and 292 (MSS Type-28 or 29).

B. Top Beam Clamps: Anvil Fig. 227 (MSS Type-25). Use for 4” pipe size and below only.

C. C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-25). Provide clamps with retaining clips. This clamp only allowed for pipe sizes 4” and smaller.

2.12 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.13 RISER CLAMPS (BARE PIPE)

A. Anvil Fig. 261 (MSS Type-8), galvanized finish.

B. Proset, Walraven, HoldRite, or Hilti system, equal to Proset proseal plug and fire-fill for sleeved and cored holes.

C. For PP-R piping, provide clamp compatible with manufacturers recommendations

2.14 RISER CLAMPS (INSULATED PIPE)

A. Unless otherwise indicated, insulated pipe riser clamps shall be Type C insulated pipe supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated riser supports. Use of contractor-fabricated riser supports is subject to approval of appropriate submittal data. Submit support detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction, for approval. Supports shall be engineered to withstand static and dynamic forces with minimum safety factor of 2.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

C. For PP-R piping, provide clamp compatible with manufacturers recommendations

2.15 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Anvil Fig. 284, Tolco No. 109 A, B-Line Fig. B3019, Powers Fasteners "Bang-It", Hilti HCI-MD, or MSCO No. MX34.

2.16 CONCRETE ANCHORS

A. Manufacturers: Hilti, DeWalt/Powers or Red Head.

B. Anchors shall be selected, sized, and detailed by Contractor's structural engineer registered in project's jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.

C. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

F. Anchors shall be zinc plated in accordance with ASTM B633.

G. Select anchors with load ratings based on cracked concrete conditions.

2.17 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb.

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 gauge.

2.18 PIPE MOUNTING PEDESTALS

A. Equal to Roof Products & System Corporation, Eaton Dura-Block, Miro Strut Series, or similar, consisting of UV resistant base with galvanized U-channel mounting strut.

2.19 PIPE GUIDES

A. Unless otherwise indicated, guides shall be by same manufacturer as pre-insulated pipe supports, equal to Shaw Pipe Shields "B", selected by load and movement.

B. For PP-R piping, provide guides compatible with manufacturers recommendations

2.20 PIPE ANCHORS

A. Unless otherwise indicated, anchors for metallic piping shall be Type C Insulated Pipe Supports. Refer to Insulated Pipe Supports in Part 2.

B. Contractor may propose to utilize contractor-fabricated anchors. Use of contractor-fabricated anchors is subject to approval of appropriate submittal data. Submit anchor system detail drawings, bearing stamp of Structural Engineer registered in project jurisdiction, for approval. Anchors shall be engineered to withstand static and dynamic forces with minimum safety factor of 3.0. Submit insulation details addressing thermal break from building structure and vapor barriers.

C. For PP-R piping, provide anchor compatible with manufacturers recommendations

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening. Wall brackets may only be used with concrete or CMU walls.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping, conduit, and ductwork shall be supported independently from other piping, conduit, or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Install adequate supports during erection of piping so as not to over stress either piping or equipment to which piping is connected.

H. Refer to Section 230000 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

I. Top beam clamps shall be used in lieu of C-clamps when hanging 3" and larger pipe from top chord of roof trusses or top flange of beams.

3.2 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. PP-R Pipe

Pipe Size	Max Spacing
All sizes	4'-0"

C. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4" and smaller	7'-0"
1-1/2"	9'-0"
2"	10'-0"
2-1/2"	11'-0"
3" and over	12'-0"

D. Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4" and smaller	5'-0"
1" to 1-1/4"	6'-0"
1-1/2" to 2-1/2"	8'-0"
3" and larger	10'-0"

E. Support plastic pipe at all changes in direction. Adequate consideration shall be given to piping expansion.

F. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

G. Spacing less than indicated above may be required to conform with building structure design or loading limitations.

H. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

I. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

J. For non-metallic pipe, follow manufacturer’s installation recommendations in addition to requirements noted herein.

K. Install supports for vertical piping and anchors as recommended by pipe manufacturer with minimum support spacing provided at every floor level.

L. Place hangers and supports to meet requirements of Section 232116 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.

M. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

N. Place hangers and supports within one foot of either side of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" and larger.

O. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

P. Place hanger or support on each side of flexible piping connections.

3.3 RISER SUPPORTS

A. Insulated Piping:

1. Unless otherwise indicated, support vertical piping as indicated below.
2. Support vertical piping at bottom of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at top of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.
3. Guide vertical piping 2" and smaller at every floor. Guide 2-1/2" and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 230550 - Vibration Isolation.

B. Non-Insulated Piping:

1. Unless otherwise indicated, maximum vertical support spacing for ambient bare steel pipes shall be 15 ft.
2. Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft.
3. Install riser clamps and intermediate supports as required.
4. Rest riser clamps on floor or on pipe sleeve.

3.4 INSULATION PROTECTION SHIELDS

A. Install insulation protection shields at support points in conjunction with Weight Bearing Insulation Inserts.

1. Use one shield (bottom) for clevis hanger
2. Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.5 INSULATION PROTECTION SADDLES

A. Install saddles at support points as specified under Insulated Pipe Supports. For steel pipes, tack weld saddle to pipe. For PP-R piping, install saddle in accordance with manufacturers recommendations Pack saddle cavity with insulation of same type as specified for piping system.

3.6 INSULATED PIPE SUPPORTS

A. Install insulated pipe supports at support points of all insulated pipe.

B. Pipe Size 1-1/2" and Smaller:

1. Use insulation protection shields. Pipe insulation specified in Section 230700 - Mechanical Systems Insulation shall be continuous through support points.

C. Pipe Size 2” and Larger:

1. Use Type C pre-insulated pipe supports.
2. In lieu of pre-insulated pipe supports, field-assembled insulated pipe supports may be used. If used, submit application details including materials, thickness, compression strength, load bearing surfaces, load calculations of support assembly and total pipe weight based on support spacing.

3. Field-assembled insulated pipe supports shall consist of weight bearing insulation inserts and insulation protection shields.
4. Insulation protection saddles may be used in lieu of assembled insulated pipe supports on roller hangers/supports for hot water pipes pipes.

3.7 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 1/2" or smaller (4” max pipe size) and only for static loading such as air piping, cold water piping, and other similar piping and ductwork. C-clamps are not allowed for hot water except hot water runouts to terminal heating devices.

C. C-clamps are not allowed for project having seismic hazard level A, B or C, as determined by Appendix A of SMACNA Seismic Restraint Manual, Second Edition - 1998.

3.8 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

B. Determine trapeze supports spacing by the smallest pipe on trapeze.

C. For support of air terminal devices, use trapeze support (minimum 1 per air terminal) with threaded rod to overhead structure. Place support so that maintenance access to air terminal is maintained.

3.9 PIPE MOUNTING PEDESTALS

A. Use for exterior piping. Install bottom of pedestal flat on surface.

3.10 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be reviewed and approved by Designer prior to installation.

3.11 PIPE GUIDES

A. Install where shown on drawings or details.

3.12 PIPE ANCHORS

A. Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

B. Do not anchor piping to concrete block walls, wood, or partition walls.

END OF SECTION 230528

SECTION 230550 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 DESIGN CRITERIA

A. Isolate all motor driven mechanical equipment, unless otherwise noted, from building structure, and from systems that they serve, to prevent equipment vibrations from being transmitted to structure. Unless specifically indicated, follow the latest edition of ASHRAE Application Handbook - Sound and Vibration Control, or manufacturer's recommendations for isolator selection whichever is more stringent.

B. Select and locate isolators to produce uniform loading and deflection. For typical units, no fewer than four isolators shall be provided. Isolators shall be provided to deflect uniformly under operating gravity and equipment thrust loadings to within ±10% of specified deflection values. Select vibration isolation devices based on the lowest operating speed of equipment.

C. Vibration Criteria:

1. All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following schedules.
2. Fans shall be balanced so that their vibration levels do not exceed 0.09-inches per second. The maximum velocity level (measured in all directions at the fan bearing(s)) shall not be exceeded when the equipment is installed per the fan manufacturer’s recommendations.
3. Vertical vibration of rotating equipment shall not be greater than levels indicated. Vibration shall be measured on equipment. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

Equipment Speed (RPM)	Maximum Allowable Vibration Displacement Peak-to-Peak (mil)
100 to 200	10
200 to 300	6
300 to 600	4
600 to 1000	3
1000 or 2000	2
over 2000	1

1.2 SUBMITTALS

A. Submit product data including, but not limited to, the following:

1. Manufacturer's name
2. Isolator type and model number
3. Materials of construction and finish
4. Dimensional data
5. Load ratings (lbs)
6. Isolator free and operating heights
7. Static deflections
8. Isolation efficiency based on lowest operating speed
9. Scaled drawings showing equipment/isolator base, equipment weight, and spring spacing
10. All other appropriate data

1.3 SUPERVISION, INSPECTION AND CERTIFICATION

A. Vibration isolation manufacturer or qualified representative shall provide supervision to assure correct installation and adjustment of isolators. Upon completion of installation and after system is put into operation, manufacturer or manufacturer's representative, shall make final inspection and submit report to Designer in writing within one week of the completion of the adjustments, certifying correctness of installation and compliance with specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials used shall retain their isolation characteristics for life of equipment served. Elastomeric materials shall comply with ASTM D2240 and shall be oil-resistant industrial grade neoprene.

B. Isolators shall be treated to resist corrosion.

C. Isolation devices subject to weather, including those within air handling units, shall have either hot-dip or cold-dip galvanized, cadmium plated, or neoprene coated finish after fabrication. Isolation devices mounted on building exterior shall also be furnished with limit stops to resist wind.

D. Springs shall be so selected and installed that the ratio of spring diameter to final compressed height shall be no less than 0.8 and no more than 1.2. Each spring shall have a minimum additional travel to solid equal to 50% of its actual deflection.

E. Ratio of lateral to vertical stiffness of vibration isolators shall not be less than 0.8 or greater than 2.0.

F. All elastomeric mounts, pads, bushings, sleeves, grommets, washers, etc., shall have a Shore-A hardness of 30 to 50 durometer after minimum aging of 20 days or corresponding oven-aging.

G. Coordinate selection of devices with isolator and equipment manufacturer.

2.2 MANUFACTURERS

A. Mason Industries, Amber/Booth Co., Aeroflex-VMC-Korfund, Vibration Eliminator, or Kinetics equal to manufacturer's model listed, except flexible pipe connections.

B. Mason, Metraflex, Proco, Twin City Hose, Hyspan, or Engineered Flexible Products (EFP) for flexible pipe connections.

2.3 TYPE 1 MOUNTS (Neoprene Pad)

A. Mason Type Super W + plate(s) or SWM, neoprene waffle pads, 3/4” thick, 30 or 40 or 50 durometer s scheduled, with a minimum 1/16” thick steel bearing plate on top. Select number and size of pads as required to accept equipment operating weight evenly. Pad areas shall be selected so no more than 15% and no less than 10% deflection occurs due to the supported load. Provide single or multiple pads and plates in series as needed to achieve specified static deflection with 1/16” thick steel shim between layers.

2.4 TYPE 2 MOUNTS (Neoprene Pad)

A. Mason Type ND or rails Type RND, double deflection neoprene mounts with cast-in metal inserts for bolting to equipment.

B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above mountings to compensate for overhang.

2.5 TYPE 3 MOUNTS (Unhoused Spring with Neoprene)

A. Mason Type SLFH, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing and complete steel baseplate with mounting bolt holes and ribbed or waffled neoprene friction pad permanently adhered to bottom. Pad shall be 5/16” to 1/2” thick, 40 durometer hardness, and sized for a load of 60 psi.

B. Mountings shall have leveling bolts rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load. Height saving brackets may be used to accommodate equipment installation.

2.6 TYPE 4 MOUNTS (Restrained Spring with Neoprene)

A. Mason Type SLR, combination spring and neoprene with rib molded base with same requirements as Type 3 above, with additional housing that includes vertical limit stops to prevent spring extension when weight is removed.

B. Installed and operating heights shall be the same. Maintain minimum clearance of 1/2" around restraining bolts and between housing and spring so as not to interfere with spring action. Limit stops shall be out of contact during normal operations. Height saving brackets may be used to accommodate equipment installation.

2.7 TYPE 5 HANGERS (Spring Hanger with Neoprene)

A. Mason Type 30N, vibration hangers with steel spring and neoprene element in series. Neoprene element shall be molded with rod isolation bushing that passes through hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30-degree arc before contacting hole and short-circuiting spring. Neoprene cup shall be minimum 1/4” thick and maximum 50 durometer.

B. Mason Type DNHS may be used where load rating and specified deflection cannot be accommodated by Type 30N.

2.8 TYPE 6 HANGERS (Pre-Compressed Spring Hanger with Neoprene)

A. Mason Type PC30N, vibration hangers similar to Type 5, but precompressed to rated deflection so as to keep piping or equipment at fixed elevation during installation. Design hangers with release mechanism to free spring after installation complete and hanger is subjected to its full load.

2.9 TYPE 7 HANGERS (Spring Hanger with Deflection Indicator)

A. Mason Type HES, steel spring in steel housing including deflection indicator scale. Hangers shall be preset at factory for required load. Select hangers so that actual loads do not exceed rated capacities (lbs).

B. Submittals shall include isolator rated deflection, required deflection and supporting calculation. Calculations shall be made by registered mechanical or civil engineer demonstrating structural adequacy of hanger and that hanger connections to building and pipe are adequate for live and dead loads encountered.

2.10 TYPE 8 HANGERS (Spring Hanger with Neoprene)

A. Mason Type 30, laterally-stable steel spring set in neoprene cup manufactured with bushing to prevent short-circuiting of hanger rod. Neoprene cup to contain steel washer designed to properly distribute load on neoprene and prevent its crushing. Spring diameters and hanger box lower hole size to be large enough to permit hanger rod to swing through 30-degree arc before contacting hole and short-circuiting spring. Neoprene cup shall be minimum 1/4" thick and maximum 50 durometer. Provide hangers with rod attachments or eyebolts on spring end.

2.11 TYPE 9 HANGERS (Neoprene)

A. Mason Type HD, vibration hangers with double-deflection neoprene-in-shear element contained in a steel housing. Neoprene element shall be molded with rod isolation bushing that passes through hanger housing to prevent metal-to-metal contact between rod and housing. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30-degree arc before contacting hole and short circuiting spring. Neoprene shall be no harder than 50 durometer.

2.12 TYPE S BASES (Steel Base)

A. Mason Type WF, structural steel bases, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. Perimeter members shall be beams with minimum depth equal to 1/10 of longest base dimension, but not less than 4". Beam depth need not exceed 14" provided that deflection and misalignment is kept within acceptable limits as determined by manufacturer. Employ height saving brackets in all mounting locations to provide base clearance of at least 1" above floor or housekeeping pad.

2.13 TYPE I BASES (Inertia Base)

A. Mason Type BMK rectangular or T shaped structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells. Base depth need not exceed 12" unless specifically recommended by base manufacturer for mass, rigidity or component alignment. Base depth shall be a minimum of 1/10 of longest base dimension, but not less than 6". Forms shall include minimum concrete reinforcement consisting of 1/2" bars welded in place on minimum 8" centers running both ways in layer 1-1/2" above bottom or additional steel as required by structural conditions. Furnish forms with drilled steel members with sleeves welded below holes to receive equipment anchor bolts where anchor bolts fall in concrete locations. Employ height saving brackets in all mounting locations to maintain base clearance of at least 1" above floor or housekeeping pad.

2.14 TYPE T THRUST RESTRAINTS

A. Mason Type WB, horizontal thrust restraint consisting of spring element in series with neoprene pad as described for Type 3 mounts with the same deflection as specified for mountings or hangers. Spring element shall be contained within steel frame and designed so it can be preset for thrust at factory and adjusted in field for maximum of 1/4" movement at start and stop. Furnish thrust restraints complete with rods and angle brackets for attachment to both equipment and ductwork or equipment and structure. Attach horizontal restraints at centerline of thrust and symmetrically on either side of unit.

2.15 TYPE ADA PIPE ANCHORS AND TYPE VSG GUIDES

A. Mason Type ADA all-directional acoustical pipe anchors and Type VSG guides for vertical piping consisting of telescopic arrangement of 2 sizes of steel tubing separated by minimum 1/2" thickness of heavy duty neoprene and neoprene isolation material. Vertical restraints shall prevent vertical travel in either direction. Allowable loads on isolation materials shall not exceed 500 psi and design shall be balanced for equal resistance in any direction.

B. Submittals shall include supporting calculations by registered mechanical or civil engineer indicating anchor/guide loads and isolator selection.

2.16 WASHER BUSHINGS (Neoprene)

1. Mason Type HG, one-piece molded bridge bearing neoprene washer/bushing. Bushing shall surround anchor bold or hanging rod and have flat washer face to avoid metal-to-metal contact.

2.17 FLEXIBLE PIPING CONNECTIONS

A. Provide flexible connections for all piping connected to rotating or reciprocating equipment and equipment mounted on vibration isolators.

B. Flexible connection shall be suitable for pressure, temperature and fluid involved, but not less than 250 psig working pressure at 250 °F.

C. Unless otherwise specified, minimum live length of metal flexible hose shall be selected to provide transverse movement of ± 3/4", but not less than 12”.

D. Water System:

1. Connections up to 6” shall consist of Kevlar or Nylon tire cord fabric reinforced with EPDM cover and liner. Solid steel rings shall be used within raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not allowed. Furnish connections with control rod or cable assemblies as recommended by manufacturer.
2. 2" and Smaller: Threaded connections, single sphere design similar to Mason SAFEFLEX SFU.
3. 2-1/2" through 6”: Floating steel flange connections, two sphere design with ductile iron or plated carbon steel reinforcing rings, similar to Mason SAFEFLEX SFDEJ.
4. Connections over 6” shall consist of Class 150 flanged bellows type connectors constructed from laminations or multiple laminations of Type 304 stainless steel conforming to ASTM A240. Furnish complete with restraining bolts, Type 304 stainless steel flow liners, rated for 150 psi operating pressure at 210 °F similar to Hyspan Series 5500/R.

2.18 PERFORMANCE

A. Select vibration isolation devices to achieve either minimum 95% isolation efficiency or minimum static deflection and mounting requirements listed below, whichever is greater. Minimum static deflections listed below are not nominal but certifiable minimums with actual installed load. Unless otherwise indicated, apply requirements listed for floor mount for roof-mounted equipment.

Type of Equipment	Ground Supported Slab		Raised Slab Span							
			20 Feet		30 Feet		40 Feet		50 Feet	
	Type	Min. Defl. (in.)	Type	Min. Defl. (in.)	Type	Min. Defl. (in.)	Type	Min. Defl. (in.)	Type	Min. Defl. (in.)
Fan/Blower Coil Units: Suspended	-	-	8	1.0	8	1.0	8	1.0	8	1.0
Air Cooled Condensing Units	-	-	4	0.75	4	1.5	4	2.5	4	3.5
Packaged Air Handling Units (without internal fan isolation): Floor Mounted	4	1	4	1	4	1.75	4	1.75	4	1.75
Pumps: Split-coupled inline pumps Floor Mounted Suspended	Support floor mounted inline pumps by pipe support stands or support frame from floor as specified and detailed. Use Type 4 mount with 2” minimum deflection. Support suspended inline pumps by connected pipes. Provide spring hangers for connected piping as specified in this section.									
Inline Fans: Suspended	Use Type 5 hangers with deflection from blower minimum deflection guide below.									
Piping Connected to Rotating or Reciprocating-Equipment:	Use flexible piping connections, and flexible hangers within the room with the source equipment and within 50 ft distance from the equipment room walls. Hangers connected to equipment supported on neoprene isolators shall use Type 9 hangers with 0.2” minimum deflection. Hangers connect to equipment supported on spring isolators shall use Type 6 hangers with 1” minimum deflection. Where piping is floor-supported, above requirements shall apply, but use Type 3 mounts instead of hangers. Flexible piping connection shall not be used for in-line pumps that are supported by connected pipes. Type 6 hangers with 1.0" minimum deflection shall be applied within one foot of both sides of in-line pump and for distance of 100 pipe diameters or 50 ft away from first hanger at in-line pump, whichever is greater.									
Vertical Pipe Risers:	Use Type 6 hangers, Mason Industries Type ADA anchors and Type VSG guides as stated in Division 23 Section Mechanical Supporting Devices.									
Piping 2.5” and Larger Supported from Underside of Occupied Floors	Use Type 5 hangers with 0.75” minimum deflection.									
Ductwork Connected to Fan Outlet:	Use Type 8 hangers with 0.75" minimum deflection within the room of the source equipment.									
Ductwork in Mechanical Equipment Rooms:	Use Type 8 hangers with 0.75" minimum deflection for ducts with cross sectional area greater than 2.0 sq ft, and where either air velocity is greater than 2000 fpm, or pressure class is 4" WG or higher.									

BLOWER MINIMUM DEFLECTION GUIDE

	Required Deflection (Inches)				
Minimum Fan Speed (rpm)	On Grade	20 ft Floor Span	30 ft Floor Span	40 ft Floor Span	50 ft Floor Span
Up to 300	2.5	3.5	3.5	3.5	3.5
301 - 500	1.5	1.5	2.5	2.5	3.5
501 and Over	0.75	1.5	1.5	2.5	3.5

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and adjust vibration isolation devices as specified, as shown on drawings and according to manufacturer's recommendations.

B. In no case shall installation short circuit isolation devices. Install flexible piping connections on equipment side of shut-off valves.

C. No mechanical equipment or piping shall make rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to: roofs, floors, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems. Space all vibration-isolated equipment and isolated components and all vibration isolators (including rods and wires) so as to be entirely free of any contact with any building element in any reasonable operating position.

D. The installation or use of vibration isolators shall not cause any change of position of equipment or piping or ducts that results in stresses in any connections or misalignment of shafts or bearings. In order to meet this objective, equipment, piping, and ducts shall be maintained in a rigid position during installation. The load shall not be transferred to the isolators until the installation is complete and in operational condition.

E. All electrical connections to vibrating equipment shall be made using liquid tight flexible conduit. Refer to Division 26. Provide flexible electrical conduit installed grossly slack so that there is at least 1” movement in any direction at the midpoint of the conduit.

F. Release restraining washers and nuts in order to "free" all precompressed spring hangers.

3.2 FLOOR MOUNTED EQUIPMENT

A. Unless otherwise shown or specified, all base-mounted equipment shall be set on 6-inch thick, hardrock concrete housekeeping pads. Vibration isolators shall be bolted to the housekeeping pad. The pad dimensions shall exceed the equipment footprint (including floor mounts) by at least 24-inches in each direction (i.e. 12-inches per side).

B. Unless otherwise indicated, a minimum clearance of 1 inch shall be provided between the top of a housekeeping pad or floor or roof and the underside of an equipment unit or steel base frame that is vibration-isolated. This space shall be cleaned thoroughly of all dirt and debris.

C. For isolation equipment with neoprene pads bearing directly on structure, fasten the isolator base plates to the building structure with suitable bolts. Isolate steel bolts from steel base plates with neoprene bushings or washers and sleeves minimum 1/4-inch-thick and maximum 40 durometer hardness. Provide steel washers to distribute bolt head loads to neoprene bushings or washers below. Size bolt holes in isolator bases to account for neoprene bushings or sleeves.

3.3 CEILING AND ROOF SUSPENDED EQUIPMENT

A. Ceiling or roof-suspended equipment shall be supported from the heaviest possible structure, such as trusses or joists. If necessary, provide heavy extra sub-structure between the building's existing heavy structure in order to support vibration-isolated equipment. Do not suspend equipment from roof decks or floors without approval of the Architect. Connect vibration isolation hangers directly to, or as close as possible to, heavy structure.

B. Hanger rods shall be aligned and free of contact with hanger boxes.

3.4 ACOUSTICAL DUCT AND PIPE PENETRATIONS

A. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below, and vertical framing between and to the sides as required. Provide the above, escutcheon plates, and anything else necessary to make the penetrated structure as solid and massive near the penetrations as away from the penetrations.

B. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster, or drywall compound full depth and all around--but only to a maximum width of 1-inch or the requirements of the above paragraph shall not have been satisfied.

C. Pack the 1/2-inch wide annular opening with glass fiber between metal sleeve and penetrating element full depth all around to a firm degree of compaction. Leave a 1/2-inch deep annular opening free at each end of the metal sleeve; fill this fully with acoustical sealant.

D. Provide acoustical duct and pipe penetrations as described above for services penetrating the following spaces:

1. Greenscreen and Podcast Room
2. Leve 1 Mechanical Room
3. Grand Reading Room
4. The Lookout

3.5 ISOLATION BASES

A. Provide required concrete for Type I inertia bases. Refer to Division 23 Section General Mechanical Requirements for concrete work.

B. Provide housekeeping pad under both Type S and Type I bases when installed on floor slab. Provide structural steel under both Type S and Type I bases when installed within air handling units.

3.6 FLEXIBLE PIPING CONNECTIONS

A. For flexible piping connections 2-1/2” and larger, use flange type recommended by manufacturer.

END OF SECTION 230550

SECTION 230553 - MECHANICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: For identification materials and devices.

B. Valve Schedules: For each piping system as specified in this Section.

C. Colored jacket schedule: For each piping system as specified in this section including sample color chips.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

A. Marker System:

1. Manufacturers: Brady USA, Marking Services Inc (MSI), or Seton.
2. Manufacturer's standard preprinted marker with color coding as indicated herein and lettering size and length of color field according to ASME A13.1.
3. Use pressure-sensitive type unless “snap-on” or “strap-on” type is specified in Part 3. “Strap-on” type may be used for piping over 6” size. Use of adhesive labels shall not be permitted.
4. Markers used for underground piping systems shall be magnetic type construction.

B. Valve Tags:

1. Minimum 1-1/4" diameter, 0.032" thick, polished brass or 316 stainless steel.

C. Laminated Plastic Nameplates:

1. ASTM D 709, Type I, cellulose, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore.
2. Nameplates shall be approximately 1-1/2" x 4", 1/16" thick, and have 1/2" high lettering. Face of plastic shall be black with white letters.
3. Fasteners shall be self-tapping, stainless steel screws or contact-type with permanent adhesive.

PART 3 - EXECUTION

3.1 GENERAL

A. This project will involve colored jackets for exposed mechanical piping.

B. After covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

C. Where markers are used in high heat applications, specifically select marker material for those applications.

D. Pipe markers and pipe jacketing shall be as follows:

Piping System	Pipe Abbreviation	Pipe Jacket Color
Chilled Water Supply	CHS	Dark Blue
Chilled Water Return	CHR	Dark Blue
Heating Hot Water Supply	HWS	Orange
Heating Hot Water Return	HWR	Orange
Non-Potable Water	NPW	Purple
Refrigerant Suction	RS	---
Refrigerant Liquid	RL	---
Refrigerant Hot Gas Reheat	RHG	---
Equipment Hangers and Attachments		Black
Notes: Use Black Jacketing for any exposed service in architecturally finished "black" ceiling cavity Paint jacketing for any exposed service per architect's direction as specified in architectural "finished" spaces		

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe identification on each system. Place flow directional arrows at each pipe identifier.

B. Identify all piping, not less than once every 25 ft, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.

C. Identify piping with "snap-on" or "strap-on" marker system depending on applicable pipe size. For "strap-on" type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

D. Markers to comply with ANSI A13.1 for color, length of color field and include flow directional arrows integrated into the marker.

E. For insulated pipe systems, lettering sizes are as follows;

1. For pipes up to 1 inch, use 1 inch letters.
2. For pipes 1-1/4 inch to 2 inches, use 2 inch letters.
3. For pipes 2-1/2 inches to 6 inches, use 3 inch letters.
4. For pipes above 6 inches, use 4 inch letters.

F. For uninsulated systems, lettering sizes are as follows:

1. For pipes up to 1 inch, use ½ inch letters.
2. For pipes 1-1/4 inch to 2 inches, use 1 inch letters.

G. Insulated piping in exposed areas shall have colored PVC jacketing. Piping in all other areas will have color coded banding provided at each location where pipe marker occurs. Refer to Color Chart for banding colors.

3.3 VALVE IDENTIFICATION

A. Identify valves with brass tags bearing valve identification number. Attach tag to valve body with brass jack chain and “S” hook. Non-metallic fasteners are not allowed. Coordinate with Owner for numbering convention prior to fabricating tags.

B. Valve tags are not required at terminal devices unless valves are greater than 10 ft from device or located in another room not visible from terminal unit.

C. Unless otherwise noted by Owner, valve number shall be prefixed with corresponding piping system identification letters.

D. Furnish typewritten charts indicating fixtures, equipment or areas served by each numbered valve, valve size, ID, model, manufacturer, service and incorporate in O&M Manuals. Provide additional typewritten copy of valve schedule with plastic protective covering and locate in conspicuous area within each mechanical equipment room.

3.4 DUCTWORK IDENTIFICATION

A. Identify all ductwork, including supply, return, exhaust, transfer, and outside air.

B. Identify duct system with pressure sensitive marker on exterior of duct or insulation jacket by name as either "Supply Air (AHU-x)", "Return Air (AHU-x)" or "Exhaust Air (EF-x)". “-x” shall indicate the actual system number (e.g., AHU-1).

C. Markers shall be 2" (min) lettering, shall include direction arrow and shall be on the bottom of the duct or insulation jacket such that it is visible from the floor below.

D. Markers shall be at intervals of 20' (max).

E. Do not identify systems exposed in architecturally "finished" spaces.

3.5 EQUIPMENT IDENTIFICATION

A. Identify all major equipment, including air handling units, fans, air terminal devices, cabinet unit heaters, fan coil units, pumps, tanks, control panels, variable frequency drives, air and water flow meters, etc.

B. Identify equipment with laminated plastic nameplates.

C. Use adhesive rather than screws when applying nameplates to air terminal devices.

D. Identify control equipment and DDC panels with laminated plastic nameplates.

E. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if original nameplates are not located for easy reading.

3.6 CONCEALED VALVE AND EQUIPMENT IDENTIFICATION

A. Provide identification on adjacent finished surfaces or on ceiling grid for all valves (except terminal unit valves) and equipment (e.g. air terminals, fans, fire and fire/smoke dampers, control transformers, control panels, etc.) located in concealed spaces.

B. Marking convention to be as specified below or similar convention approved by Owner for location of all equipment and valves located above ceilings.

1. Identify concealed shut-off valves with a ½"Ø (min) black dot affixed to the ceiling.
2. Identify concealed air terminal boxes and other equipment with engraved phenolic label matching ceiling color with ¼" (min) black lettering (or other contrasting color) affixed to the ceiling.
3. Identify concealed remote damper gang locations with engraved phenolic label matching ceiling color with ¼" (min) black lettering (or other contrasting color) affixed to the ceiling.

C. Locate labels on ceiling grid for lay-in ceilings or on access panel for inaccessible ceilings.

3.7 MISCELLANEOUS LABELING

A. Contractor shall provide pre-printed label on each space temperature sensor to identify VAV box or chilled beam served by sensor.

3.8 ACCESS PANEL IDENTIFICATION

A. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O and M Manuals.

END OF SECTION 230553

SECTION 230594 - WATER SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. TAB Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for HVAC hydronic systems, such as pumps, coils, fan coils, air terminal reheat coils and other processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems (including branch balancing valves), and terminal units connected. Scope of work also includes coil performance for air handling units and terminal heating devices. Make attempts to balance flows to values indicated. If flow is low, attempt to proportional balance to same percentage below design.

D. TAB contractor shall be present during commissioning of hydronic systems to make operational adjustments on system components as required.

E. TAB contractor shall review and approve the type and location of balancing valves installed by the Mechanical Contractor.

F. Test and balance personnel shall be qualified to perform testing and balancing procedures in accordance with AABC / ANSI AABC National Standards for Total System Balance (2016), 7th Edition, as applicable to mechanical air and hydronic distribution systems and associated equipment and apparatus, or NEBB-2005, Procedural Standards for Testing, Adjusting, and Balancing of Environment Systems. Each person who will be performing TAB work on the project shall be AABC or NEBB certified.

G. Contractor shall contract with an independent TAB Contractor to perform all testing, adjusting, and balancing of HVAC hydronic systems required for this project. Work related to testing, adjusting, and balancing that must be performed as specified in other sections of these specifications. TAB subcontractor shall prepare Quality Assurance Submittal for approval.

H. TAB Contractor shall contact Designer and Commissioning Agent at least 10 days prior to start of balance work. Owner and/or commissioning agent may elect to be present for all or portions of balance work.

I. TAB work shall not proceed until all hydronic systems have been pressure tested, cleaned, and flushed and all temporary strainer media has been removed and all required control and hydronic specialties have been installed in piping. TAB fieldwork shall not begin on any system / equipment item until signed prefunctional checklists (PFCs), pertaining to applicable equipment, have been submitted by the installing contractor to the TAB agency, and copied to the independent CxA and the EOR. See specification 23 00 00, paragraph 3.9.A, for additional system readiness requirements pertaining to the start of TAB fieldwork.

J. TAB Contractor shall work with Control Contractor to verify control setpoint for differential pressure transmitters as part of hydronic balance requirements.

K. Upon direction of Designer or TAB Contractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at the minimum pressure differential.

L. TAB work shall not proceed until all assigned personnel have been approved by Designer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Designer. Refer to Div 1 for required participants in the TAB Verification Tests.

M. TAB work shall be completed and final report submitted to Designer before Final Inspection and before start of functional testing by Commissioning Agent.

N. Copies of all TAB contractor generated deficiency reports shall be submitted to the Cx Authority, owner and EOR to ensure that the appropriate installing contractors have received copies of the reports, and to help ensure that immediate attention can be given to addressing and resolving the various deficiencies identified. No retesting of submitted deficiency items shall be attempted by the TAB contractor until signed copies of the deficiency reports, certifying completion of the item, have been received back by the TAB contractor from the applicable installing contractor.

O. Preliminary copies of the final TAB report for a given phase shall be made available to the Cx team at the completion of the TAB fieldwork, for the TAB performance verification of the Cx procedures by the independent CxA for that phase of the work.

P. The TAB contractor shall provide one (1) technician with full instrumentation for the purpose of verifying the data submitted in the final TAB report. The verification will be conducted by the independent Cx agency. The Cx authority (CxA) will randomly select at least 10% of non-critical systems and 100% of critical systems for performance verification purposes and oversee the TAB contractor's retesting of these items. Non-critical systems are those whose sole purpose is to maintain thermal comfort conditions. Critical systems are those which maintain pressure cascades in containment spaces. If 10% or more of the retested items are found to be plus or minus 10% or more out-of-tolerance of published final TAB report values, then the TAB contractor shall be liable for retesting part or all of the specific HVAC system before undergoing further performance verification. However, all out-of-design-tolerance values identified shall be reported and corrected by the contractor.

1.2 SUBMITTALS

A. General:

1. Make submittals in accordance with project submittal procedure. Submit minimum of 6 copies of submittals unless otherwise directed (3 for O&M Manuals, 1 for Designer, 1 for Contractor, and 1 for Commissioning Agent).
2. Reports shall be assembled using 3-ring hard cover binder with project name and location on cover and side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB or AABC wherever possible. Provide numbered tabs for each system. Provide sortable electronic version as well as hard copy. Assemble report in the following order:

   a. Transmittal letter
   b. Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor and Designer (Engineer and Architect).
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:

      1) Equipment data and measurement summary
      2) Equipment measurement data
      3) Branch main measurement data
      4) Terminal device measurement data

B. Quality Assurance Submittal:

1. Contractor shall submit the following information:

a. Firm resume

1) AABC or NEBB active membership certificate
2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

b. Supervisor resume
c. Balance technician(s) resumes. Submit only resumes for those individuals who will be onsite and actively working on the project.

2. All persons performing work shall be AABC or NEBB certified.
3. Designer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Designer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Designer and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Designer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Final Report shall be submitted to Designer at least 10 days prior to Final Inspection. The Final Report shall also be available at the Final Inspection for the Designer and State Construction review. Submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.3 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, and ASHRAE publications for establishing required procedures.

1. ANSI / ASHRAE STANDARD 111-2008, MEASUREMENT, TESTING, ADJUSTING, AND BALANCING OF BUILDING HVAC SYSTEMS
2. AABC / ANSI AABC National Standards for Total System Balance (2016), 7th Edition

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Designer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB or AABC Standards but not more than 1 year old.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

1. Prior to notifying the TAB agency that a given system is ready for TAB fieldwork to begin, the Contractor shall conduct the following final checks:

a. Repair all piping system leaks identified during hydrostatic pressure testing, and shall have taken every precaution to ensure that all hydronic systems declared ready for TAB hydronic fieldwork to begin have had all fluid isolation valves and stop cocks verified fully open.
b. Bleed & vent all entrained air from circulating water systems.
c. Confirm that all hydronic systems / equipment in the phase designated “ready for testing” have undergone startup procedures, are currently operational, online, and operating in “steady-state” mode.

B. TAB Contractor shall coordinate and arrange an onsite meeting with Construction Manager, Engineer, Commissioning Agent, Controls Contractor, and Mechanical Contractor prior to start of TAB work to discuss methodology for testing systems and review any outstanding work to be performed which may impact TAB work.

C. Unless otherwise specified, maximum acceptable offset tolerance shall be ± 10% of design flow rates for terminal heating / cooling equipment and 0 to +10% of design flow for major or critical equipment (i.e., air handling unit coils, fan coil units serving IT spaces, pump and heat exchanger balancing) as indicated on drawings and schedules.

D. The TAB agency shall notify the contractor in writing, on a daily basis, of any deficiencies discovered during TAB fieldwork. The Contractor shall repair all deficiencies noted by the TAB agency in a timely manner, and shall notify the TAB agency immediately, in writing, upon completion of the repairs. The extra costs associated with re-testing by the TAB agency due to deficient and / or un-repaired items that were certified as ready and / or repaired will be borne by the Contractor.

E. The final testing and balancing report, insofar as it is possible, shall not contain deficiency items that are readily repairable. Insofar as it is possible, all deficiencies identified by the TAB agency, shall have been corrected prior to submission of the Final TAB Report. Preliminary TAB reports shall be submitted to the EOR and CxA and are not to be submitted to the Owner.

F. Contractor shall be responsible for all patching of materials in insulation, or equipment housings, which have been cut or drilled for test purposes.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain the latest Contract Documents including addenda, construction bulletins and change orders. Obtain shop drawings and performance curves from the Contractor for pumps, flow measuring devices, and terminal devices and include performance curves with actual operating points noted in Final Report. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.
2. Narratives: Furnish written narratives of procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow-measuring devices to be used at each pump and terminal device. Include different narratives for constant and variable flow systems. For non-standard water systems, include narratives on how to measure and adjust for different viscosities. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. Include voltage / current readings for each phase of 3 phase motors on TAB data sheets.
3. Pre-balance Checklist: shall include, but not be limited to:

    a. Check for completeness of work
    b. System cleaning
    c. System fill and air venting
    d. Place system into operation
    e. Pump bearings, alignment, starters, vibration isolators, rotation
    f. Setting valves to proper position including shut-off and bypass valves
    g. Set up of controls and control devices

4. Measuring Instrument List: List that measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:

    a. Manufacturer name and model number
    b. Measurement range
    c. Pressure/temperature limits
    d. Date put into service
    e. Date of last calibration
    f. Certificate from calibration firm

5. Designer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument that has not been recalibrated within past year.
6. Samples: Submit copies of TAB forms to be used.
7. Branch circuit and terminal measurements and adjustments: Indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flow rates (including zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial set points on forms. Final setpoints to be confirmed during balance and coordinated with Control Contractor. Final setpoint to be lowest setpoint which will achieve design flow to all devices.
8. Balance flow rates for terminal heating / cooling equipment shall be based on approved shop drawings unless modified by subsequent change.

3.3 SET-UP PHASE

A. Procedure:

1. Perform pre-balance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure pump data and flow rates in "as found" condition after initial valve settings are made.

C. Initial Test Report:

1. Submit report to Designer indicating measurements made and including notes of items that are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required prior to submitting Final Report.

B. Final Report:

1. Submit report to Designer indicating all data, measurements and adjustments as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.
2. Report shall include deviation from the design setpoints as a percentage.

C. Final Report Adjustments:

1. Designer reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance. Contractor shall resubmit all or portions of Final Report as directed by Designer.

END OF SECTION 230594

SECTION 230596 - AIR SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. TAB Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for air systems, such as air handling units, return fans, exhaust fans, air terminal devices, fan coils, split systems, diffusers, grilles and other air moving processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein. Balancing work shall be done for all equipment operating modes (normal operating mode, economizer mode, etc.).

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems (including branch main balancing), and terminal units connected.

D. Test and balance personnel shall be qualified to perform testing and balancing procedures in accordance with AABC / ANSI AABC National Standards for Total System Balance (2016), 7th Edition, as applicable to mechanical air and hydronic distribution systems and associated equipment and apparatus, or NEBB-2005, Procedural Standards for Testing, Adjusting, and Balancing of Environment Systems. Each person who will be performing TAB work on the project shall be AABC or NEBB certified.

E. Contractor shall contract with an independent TAB Contractor to perform all testing, adjusting, and balancing of HVAC systems required for this project. Work related to testing, adjusting, and balancing that must be performed by Mechanical Contractor is specified in other sections of these specifications. TAB subcontractor shall prepare Quality Assurance submittal for Mechanical Contractor who will submit it for approval.

F. TAB Contractor shall contact Designer and Commissioning Agent at least 10 days prior to start of balance work. Designer and/or Commissioning Agent may elect to be present for all or portions of balance work.

G. TAB Contractor shall be present during commissioning of air systems for TAB verification.

H. TAB Contractor shall review and approve the type and location of balancing devices furnished and installed by Mechanical Contractor.

I. TAB work shall not proceed until all air systems have been pressure tested, cleaned, and all required control components and ductwork specialties have been installed in ductwork. TAB fieldwork shall not begin on any system / equipment item until signed prefunctional checklists (PFCs), pertaining to applicable equipment, have been submitted by the installing contractor to the TAB agency, and copied to the independent CxA and the EOR. See specification 23 00 00, paragraph 3.9.A, for additional system readiness requirements pertaining to the start of TAB fieldwork.

J. TAB Contractor shall work with Control Contractor to verify control setpoints for static pressure transmitters as part of air balance requirements.

K. Upon direction of Designer or TAB Contractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheaves, motor sheaves and/or drive belts.

L. TAB work shall not proceed until assigned personnel have been approved by Designer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Designer. Refer to Division 01 for required participants in the TAB Verification Tests.

M. TAB work shall be completed, and final report submitted to Designer before Final Inspection and before start of functional testing by Commissioning Agent.

N. Copies of all TAB contractor generated deficiency reports shall be submitted to the Cx Authority, owner, EOR and GC to ensure that the appropriate installing contractors have received copies of the reports, and to help ensure that immediate attention can be given to addressing and resolving the various deficiencies identified. No retesting of submitted deficiency items shall be attempted by the TAB contractor until signed copies of the deficiency reports, certifying completion of the item, have been received back by the TAB contractor from the applicable installing contractor.

O. Preliminary copies of the final TAB report for a given phase shall be made available to the Cx team at the completion of the TAB fieldwork, for the TAB performance verification of the Cx procedures by the independent CxA for that phase of the work.

P. The TAB contractor shall provide one (1) technician with full instrumentation for the purpose of verifying the data submitted in the final TAB report. The verification will be conducted by the independent Cx agency. The Cx authority (CxA) will randomly select at least 10% of non-critical systems and 100% of critical systems for performance verification purposes and oversee the TAB contractor's retesting of these items. Non-critical systems are those whose sole purpose is to maintain thermal comfort conditions. Critical systems are those which maintain thermal and humidity conditions in the Special Collections archive. If 10% or more of the retested items are found to be plus or minus 10% or more out-of-tolerance of published final TAB report values, then the TAB contractor shall be liable for retesting part or all of the specific HVAC system before undergoing further performance verification. However, all out-of-design-tolerance values identified shall be reported and corrected by the construction team.

1.2 SUBMITTALS

A. General:

1. Reports shall be assembled using 3-ring hard cover binder with Project Name and location on cover and side panel. All information sheets shall be 8-1/2" x 11" white bond paper. Use preprinted forms of NEBB or AABC wherever possible. Provide numbered tabs for each system. Provide sortable electronic version as well as hard copy. Assemble report in the following order:

   a. Transmittal letter
   b. Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor and Designer (Engineer and Architect).
   c. Index of numbered tabs listing major systems
   d. Data organized by system in the following order:

      1) Equipment data and measurement summary
      2) Equipment measurement data
      3) Branch main measurement data
      4) Terminal device measurement data

B. Quality Assurance Submittal:

1. Contractor shall submit the following information:

a. Firm resume

1) AABC or NEBB active membership certificate
2) Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional

b. Supervisor resume
c. Balance technician(s) resume. Submit only resumes for those individuals who will be onsite and actively working on project.

2. All persons performing work shall be AABC or NEBB certified.
3. Designer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Designer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:

1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Designer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:

1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Designer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Final Report shall be submitted to Designer at least 10 days prior to Final Inspection. The Final report shall also be available at the Final Inspection for the Designer and State Construction review. Submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.3 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, ASHRAE, and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publications for establishing required procedures.

1. ANSI / ASHRAE STANDARD 111-2008, MEASUREMENT, TESTING, ADJUSTING, AND BALANCING OF BUILDING HVAC SYSTEMS.
2. AABC / ANSI AABC National Standards for Total System Balance (2016), 7th Edition.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by Designer upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB or AABC Standards but not more than 1 year old.

2.2 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

1. Prior to notifying the TAB agency that a given system is ready for TAB fieldwork to begin, the Division 23 mechanical contractor(s) shall conduct the following final checks:

   a. The installing contractor shall check to ensure that all balancing dampers are locked in the fully open position for the start of the TAB fieldwork and shall be responsible for fully opening all closed and / or partially closed MBDs.
   b. The installing contractor shall confirm that he has provided a new set of clean filters during initial system startup and at the start of TAB fieldwork for all air handling units, fan coil units, ductless mini-splits, etc. Additionally, the installing contractor shall confirm that he has removed all temporary filter media and that final unit filters have been installed prior to final unit setup by the TAB agency (i.e. prior to final unit traverse).
   c. The installing contractor shall check to confirm, that wherever possible, ductwork routing / layouts have allowed sufficient ductwork length on both SA and RA side of air handlers, to enable the TAB agency to conduct pitot tube traverses to determine overall air flows."
   d. The installing contractor shall confirm that all airside systems / equipment in the phase designated "ready for testing" have undergone startup procedures, are currently operational, online, and operating in "steady-state" mode.

B. Unless otherwise specified, maximum acceptable airflow tolerance is minus 5% or plus 10% of the design flow rates as indicated on drawings and/or as scheduled.

C. For spaces which use supply air or exhaust/return air to maintain pressure relationships, supply or exhaust air shall be balanced between 100% and 110% of the design airflow. Associated exhaust/return or supply flow shall be balanced to provide indicated differential between supply and exhaust air as noted on plans. Spaces with defined pressure relationships include:

1. Special Collections archive
2. Makerspace

D. TAB Contractor shall coordinate and arrange an onsite meeting with Construction Manager, Designer, Commissioning Agent, Control Contractor, and Mechanical Contractor prior to start of TAB work to discuss methodology for testing systems.

E. The TAB agency shall notify the contractor in writing, on a daily basis, of any deficiencies discovered during TAB fieldwork. The Contractor shall repair all deficiencies noted by the TAB agency in a timely manner, and shall notify the TAB agency immediately, in writing, upon completion of the repairs. The extra costs associated with re-testing by the TAB agency due to deficient and / or un-repaired items that were certified as ready and / or repaired will be borne by the Contractor.

F. The final testing and balancing report, insofar as it is possible, shall not contain deficiency items that are readily repairable. Insofar as it is possible, all deficiencies identified by the TAB agency, shall have been corrected prior to submission of the Final TAB Report. Preliminary TAB reports shall be submitted to the EOR, CxA, and general contractor, and are not to be submitted to the Owner.

G. The Division 23 mechanical contractor shall be responsible for all patching of materials in insulation, ductwork or equipment housings, which have been cut or drilled for test purposes.

H. For spaces provided with pressure differential monitoring devices (i.e. Special Collections archive and SC Shell), TAB Contractor shall initially balance supply and relief air terminals (AT-SA2103 and AT-RA2103) to airflows indicated on air terminal schedule for occupied operation.

1. TAB contractor shall confirm and coordinate balance schedule with completion of all partition wall penetrations and door seals prior to completion of balance work.
2. During initial balancing to the indicated supply and relief air offsets, TAB contractor shall record pressure differential as observed at space pressure monitors in TAB reports. Minimum initial pressure differential shall be as indicated in the above table.
3. For the Special Collections space, design minimum pressure differential across each boundary is +0.03” wc. If air balance for space is within limits specified above and minimum pressure differential cannot be achieved, the following corrective measures shall be taken in order:

   a. Mechanical Contractor to work with Construction Manager to verify room is sealed sufficiently with no visible openings across room boundaries.
   b. Construction Manager to provide or modify door seals to ensure tight seal.
   c. If the above measures do not increase pressure differentials to minimum allowable levels, TAB Contractor to consult with Engineer who may direct TAB Contractor to modify supply and/or relief airflows from space to achieve minimum pressure differential of + 0.03” wg pressure differential across system boundary.
   d. Associated relief air terminal occupied airflow shall be reduced and supply air terminal unoccupied airflow shall be increased as necessary to meet space pressure differential setpoint.

4. For the Special Collections space, design maximum pressure differential across each boundary is +0.05” wc. If air balance for space is within limits specified above and maximum pressure differential is exceeded, the following corrective measures shall be taken in order:

   a. TAB Contractor to consult with Engineer who may direct TAB Contractor to modify supply and/or relief airflows from space to achieve maximum pressure differential of + 0.05” wg pressure differential across system boundary.
   b. Associated relief air terminal occupied airflow shall be increased and supply air terminal unoccupied airflow shall be reduced as necessary to meet space pressure differential setpoint.

3.2 PLANNING PHASE

A. Procedure:

1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:

1. Planning Report shall contain the following minimum requirements.

   a. Samples: Provide copies of all TAB forms to be used.

b. General narratives: Furnish written narratives of all procedures used. Include separate narratives for each fan and air handling system. Identify flow-measuring devices to be used at each fan, air terminal device, and air outlet. Narrative shall include statement that every air outlet shall be measured and adjusted. Provide different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances. Include voltage / current readings for each phase of 3 phase motors on TAB data sheets.

c. Air system narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes including economizer mode using 100% outside air where applicable. Differentiate between constant and variable flow systems. Include procedures for temporary blankoff of filter area in air handling units to simulate filter loading characteristics as provided on filter schedule. Include motor speed or frequency at balanced condition on TAB data sheets.

d. Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.

e. Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, Ak factor, and design velocities. As part of the scope of TAB work, provide static pressure profile of each air handling unit supply and exhaust duct system including, at a minimum, static pressure readings at branch takeoffs for each shaft and at equally spaced locations along critical duct run on each floor. Also, TAB work shall include verification of building differential pressure readings to confirm control system readings.

f. Miscellaneous measurements: TAB work shall include verification of building differential pressure readings to confirm control system readings. TAB work shall also include verification of airflow at each location in ductwork where duct mounted airflow meters are installed to confirm control system readings.

g. Procedures for establishing static pressure setpoints for control of fans in air handling units.

2. Prebalance Checklist - to include, but not limited to:

a. Check for completeness of work.
b. Verify all control components installed and operational.
c. Verify all duct specialties including airflow meters, access doors, and volume dampers are installed and accessible.
d. System cleaning if required.
e. Check fire, smoke and balancing damper positions.
f. Place system into normal operation without economizers.
g. Install test openings where required.
h. Indicate type of test holes to be used and installation procedure.
i. Chisel holes and duct tape are not allowed.
j. Note condition of filters. Verify filters used during construction period have been replaced.
k. Provide temporary blankoffs to simulate design pressure drops of filters.
l. Wet cooling coils.
m. Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation.
n. Drive belt tension and alignment.
o. Setting of automatic dampers to proper position including shutoff and bypass dampers.
p. Set up of controls and control devices

3. Measuring Instrument List - list what measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
   a. Manufacturer name and model number
   b. Measurement range
   c. Pressure/temperature limits
   d. Date put into service
   e. Date of last calibration
   f. Include certificate from calibration firm
4. Designer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.
5. Balance flow rates of terminal heating and cooling equipment shall be flow rates indicated on approved shop drawings unless modified by Field Directive.

3.3 SET-UP PHASE

A. Procedure:

1. Perform pre-balance checkout as per Planning Phase narrative.

B. Initial Test:

1. Measure fan data and flows in "as found" condition after initial damper settings are made.

C. Initial Test Report:

1. Submit report to Designer and Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:

1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:

1. Submit report to Designer and Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports. Owner shall also receive an electronic version of the final report.
2. Report shall include complete list of all calibration offsets applied throughout each system.
3. Report shall include deviation from the design setpoints as a percentage.

C. Final Report Adjustments:

1. Designer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. Contractor shall resubmit all or portions of Final Report as directed by Designer.

END OF SECTION 230596

SECTION 230700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide insulating materials and accessories as required for mechanical systems as specified below.

B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.2 DEFINITIONS

A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas including mechanical rooms shall be considered as exposed.

B. Unless otherwise indicated, unit of thermal conductivity is (BTU in) / (hr. ft2 °F).

1.3 SUBMITTALS

A. Shop drawings for each piping system for all pipe sizes, each ductwork system, and all equipment including, but not limited to, the following:

1. Manufacturer's name
2. Schedule of insulating materials
3. Insulation material and thickness
4. Jacket
5. Adhesives
6. Fastening methods
7. Fitting materials
8. Intended use of each material
9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
10. Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable.)
11. Acoustical duct lagging removable access procedure
12. All other appropriate data

1.4 DELIVERY, STORAGE AND HANDLING

A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Owens Corning, Johns Manville, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

2.2 MATERIALS

A. Unless otherwise indicated, all products, material itself or on a composite basis, shall meet ASTM E-84, UL 723 or NFPA 255 and shall not exceed 25 flame spread and 50 smoke developed.

B. All duct coverings and linings (including adhesives) shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at their rated temperatures (not less than 250°F).

2.3 INSULATION

A. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall have dry density of no more than 38 lb/ft3, thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.

D. Filling and finishing cement shall have dry density of no more than 24 lb/ft3, thermal conductivity of 0.74 at 500°F mean temperature, and service temperature to 1900°F.

E. Type A Insulation (Closed Cell Elastomeric Thermal Insulation):

1. Minimum nominal density of 6 lb/ft3, thermal conductivity not more than 0.27 at 75°F mean temperature, maximum water vapor transmission of 0.06 perm-inch and suitable for temperatures from -70°F to 220°F, Armacell Model AP/Armaflex, K-Flex USA, or Aeroflex Model Aerocel.

F. Type F Insulation (Flexible Glass Fiber):

1. Minimum density of 0.75 lb./ft3 with thermal conductivity of not more than 0.29 at 75°F mean temperature, and suitable for temperatures to 250°F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite EQ Type 75, Knauf Atmosphere Duct Wrap.

G. Type G Insulation (Cellular Glass):

1. 100% cellular glass cells with no organic material, noncombustible, 0.00 perm-inch permeability, 7.5 lb/ft^3 average density, compression strength 90 psi, thermal conductivity of not more than 0.31 at 50°F mean temperature and service temperature of 900°F. Pittsburgh Corning Foamglas or approved equal.

H. Type H Insulation (High Temperature Block or Pipe):

1. Hydrous calcium silicate, suitable for temperatures to 1200°F, thermal conductivity not more than 0.50 at 400°F, dry density 13 lb/ft^3 minimum and compressive strength 100 psi. Industrial Insulation Group Thermo-12 Gold, or approved equal.

I. Type P Insulation (Expanded Polyisocyanurate):

1. Continuously molded rigid polyisocyanurate foam insulation meeting requirements of ASTM C-591, with thermal conductivity of not more than 0.19 at 75°F mean temperature, minimum nominal density of 2 lb/ft3, minimum compressive strength of 24 psi, maximum water vapor transmission of 4.0 perm-inch, maximum water absorption of 2% by volume, and suitable for temperature of plus 300°F down to -297°F. Insulation shall have factory-applied jacket with SSL. Johns Manville Trymer 25-50, or approved equal.

J. Type PP Insulation (Phenolic):

1. Continuously molded rigid foam insulation meeting requirements of ASTM C1126, with thermal conductivity of not more than 0.15 at 75°F mean temperature, minimum density of 2.5 lb/ft3, minimum compressive strength of 27 psi, maximum water vapor permeability of 2.14 perm-inch, and suitable for temperature of plus 248°F down to -290°F. Insulation shall have factory-applied jacket with SSL. ITW Supercel Phenolic, Dyplast DyTherm Phenolic or Resolco Insul-Phen.

K. Type R Insulation (Rigid Glass Fiber):

1. Minimum nominal density of 3 lb/ft3, with thermal conductivity of not more than 0.23 at 75°F mean temperature. Minimum compressive strength at 10% deformation shall be 25 lb/ft2.
2. Pipe insulation shall be premolded type in accordance with ASTM C547 Type I, suitable for temperatures to 850°F, Johns Manville Micro-Lok, Owens Corning Fiberglas ASJ/SSL-II or Knauf Earthwool 1000° pipe insulation.
3. Duct and equipment insulation shall be in accordance with ASTM C612, Type IA and IB, suitable for temperatures to 450°F, Johns Manville Spin-Glas Type 814, Owens Corning Type 703, Knauf Insulation Board.
4. Pipe and tank wrap faced with specified jacket may be used for equipment and round ducts insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

L. Type RR Insulation (Rigid Glass Fiber):

1. Minimum nominal density of 6 lb/ft3, with thermal conductivity of not more than 0.22 at 75°F mean temperature. Insulation shall be suitable for temperatures to 450°F. Minimum compressive strength at 10% deformation shall be 200 lb/ sq ft, Johns Manville Spin-Glas Type 817, Owens Corning 705, or equivalent.
2. Pipe and tank wrap faced with specified jacket may be used for equipment and round duct insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

2.4 JACKETS

A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 procedure A.

B. Type D-1 Jacket:

1. Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish or white vinyl finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ", Johns Manville "AP", Knauf “ASJ”.

C. Type D-2 Jacket:

1. Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK", Knauf “FSK”.

D. Type P-1 Jackets:

1. Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with burst strength of 50 beach units minimum and tensile strength 45 lbs/in minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ-SSL", Johns Manville "ASJ" and Knauf ASJ+.

E. Type P-2 Jackets:

1. Jackets shall be minimum 5 ply laminated, weather proofing material with acrylic adhesive capable of installation with no additional mechanical attachments, 0.00 water vapor permeance rating per ASTM E-96, mold inhibitors incorporated and UV stable, Venture Clad 1577 CW, Alumaguard Lite, or approved equal.
2. Jackets shall have embossed aluminum finish.

F. Type S-1 Jacket:

1. Saran Vapor Retarder Film with self-sealing lap (SSL), ASTM C-755 and C-1136, 6 mil thickness. Permeance shall not exceed 0.01 perms, equal to Dow Saran 560.
2. Elbows, fittings, valves and butt joints shall be wrapped with 3 layers of Dow Saran 520 Vapor Retarder tape.
3. Provide PVC jacket (Type V-1) over Saran tapes for exposed elbows, fittings and valves.

G. Type V-1 Jacket:

1. Fire retardant and UV resistant PVC in minimum 20 mil (0.02") thickness consisting of preformed fitting covers, preformed end terminations, and sheet material for straight runs of pipe. Material when installed according to manufacturer's instructions shall provide complete vapor barrier and readily cleanable surface while meeting Federal CGMP requirements.
2. Jacketing system shall be equal to Johns Manville Zeston/Perma-Weld System. Similar product by PROTO will be acceptable or approved equal.
3. Custom colors will be required to match piping colors specified in section 230553 – Mechanical Systems Identification.

2.5 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Products shall be compatible with surfaces and materials on which they are applied and shall be suitable for use at operating temperatures of systems to which they are applied.

B. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

C. Adhesives, mastic, sealants, and protective finishes shall be as recommended by insulation manufacturer for specified application.

D. Glass fiber fabric reinforcing shall be 10 x 10 or 20 x 10 mesh similar to Childers Chil Glas #10, Foster Mast A Fab, or Vimasco Elastafab 894.

E. Wire mesh reinforcing shall be 22 ga., 1" galvanized.

F. Insulation bonding adhesive to metal surfaces shall be equal to Benjamin Foster No. 85-20, MEI 22-25 or Childers CP-82.

G. Coating and vapor barrier treatment shall be less than 0.02 perms, equal to Benjamin Foster 30-35 or MEI 55-10, and Childers CP-30 (indoors) and Childers Encacel 5 (outdoor).

H. Lap adhesives shall be equal to Benjamin Foster 85-20, MEI 22-25 or Childers CP-82.

I. Weather proof mastic shall be equal to Benjamin Foster 35-00, MEI 55-50 or Childers CP-10.

J. Lagging adhesives shall be equal to Benjamin Foster 30-36, MEI 11-02 or Childers CP-50A.

K. Vapor barrier sealant and flashing compound shall be equal to Benjamin Foster No. 30-45, MEI 44-05 or Childers CP-30.

L. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.

1. Foster 30-33
2. Childers CP-33
3. Vimasco 749

M. Weather Barrier Breather Mastic: Above ambient insulation. Permeance shall be greater than 1.0 perms at 1/16” dry film thickness per ASTM E96.

1. Foster 46-50 Weatherite
2. Childers CP-10/CP-11 Vi Cryl
3. Vimasco WC-5

N. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.

1. Foster 30-36
2. Childers CP-50 AMV1
3. Vimasco 713

O. Metal jacketing sealant for aluminum jacketing:

1. Foster 95-44 Elastolar
2. Childers CP-76 Chil Byl
3. Pittsburgh Corning 727

P. Insulation joint sealant for Type P, Type PP, and Type G insulation:

1. Foster 95-50 Flextra
2. Childers CP-76 Chil Byl
3. Pittsburgh Corning CW Sealant

Q. Butt joint and longitudinal joint adhesive for Type A insulation shall be ArmaFlex 520, Rubatex 373, Childers CP-82 or Foster 85-75 Manville 57.

R. Weather-resistant protective finish for Type A insulation shall be equal to ArmaFlex WB Finish or Foster 30-64 elastomeric coating.

S. Finishing cement shall be ASTM C449

T. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

2.6 METAL BANDS AND WIRES

A. Aluminum bands shall be 0.5" x 0.020" up to 48" diameter and 0.75" x 0.020" over 48" diameter.

B. Stainless steel bands shall be 0.5" x 0.015" or 0.75" x 0.015".

C. Stainless steel wires shall be 16 ga.

2.7 INSULATION FASTENERS

A. Insulation fasteners shall be cup head weld pins, galvanized low carbon steel, minimum 12 ga (0.105”) pins.

B. Washer edge shall be beveled.

C. Fasteners shall be stainless steel for stainless steel ductwork application.

D. Insulation fasteners using adhesive are not allowed.

PART 3 - EXECUTION

3.1 APPLICATION

A. Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise.

Piping System							
Service	Jacket Type	Insulation Type	Insulation Thickness According to Pipe Size				
			3/4" and less	1" - 1-1/2"	2" - 3"	4" - 6"	8" and Larger
Heating Hot Water	P-1	R	1-1/2"	1-1/2"	2"	2"	2”
Chilled Water	S-1	P or PP	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Cooling Coil Condensate Drain	V-1	A	3/4"	3/4"	3/4"	3/4"	3/4"
Refrigerant Suction, Liquid, and Hot Gas (if used) (Interior)	-	A	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2”
Refrigerant Suction, Liquid, and Hot Gas (if used) (Exterior)	P-2	A	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2”
Non-Potable Cold Water	P-1 or P-2	R	1"	1"	1”	1”	1”
Low Pressure Steam and Condensate	P-1	R	2-1/2”	2-1/2”	2-1/2”	3”	3”
Exposed Piping	Provide Type V-1 jacket in addition to pipe insulation and jacket specified in this schedule. Refer to 230553 for required jacket color.						

Ductwork/Equipment System			
Service	Jacket Type	Insulation Type	Insulation Thickness
OA Ducts (Exposed)	D-1	R	2”
Supply, Return, and Relief Ducts (Exposed)	D-1	R	2”
Supply and Return Ducts (Concealed)	D-2	F	1-1/2"
Supply Air Diffuser Plenums/Back pans	D-2	F	1-1/2”
Chilled Water Pump (Removable)	V-1	A	1-1/2”

3.2 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section.

B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Any portion of insulation system which becomes wet shall be replaced with new insulating materials at no expense to Owner.

E. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

F. Where possible longitudinal joints in jackets shall face toward wall or ceiling.

G. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.

H. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.

I. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

J. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Division 23 Section General Mechanical Requirements and Division 07 Section Firestopping.

K. Insulate the following systems for complete vapor barrier protection:

1. Chilled Water
2. Cooling coil condensate drain
3. Non-Potable Cold Water
4. All insulated ductwork
5. All equipment with surface temperature below 65°F

L. Systems specified to be insulated for complete vapor barrier protection shall be insulated such that no moisture condensation occurs on exterior surfaces. If condensation occurs at any time during warranty period, Contractor shall be required to replace insulation with new and seal to prevent moisture to the satisfaction of the Owner and at no additional cost to the Owner.

M. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.3 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly.

B. Laps on factory-applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or shall be pressure sealing type lap.

C. Cover joints with factory furnished tape (3" minimum width) to match jacket. Cement firmly with lap adhesive.

D. Built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with filament tape and finished with PVC fitting covers.

E. For valves and fittings requiring vapor barrier, wrap fitting with vapor barrier tape and finish with PVC fitting covers.

F. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F, one piece PVC fitting covers, minimum thickness of 20 mil, may be used. Fitting covers located in mechanical rooms within 8 ft above floor shall be 30 mil thickness. Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match those of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

G. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

H. For piping up to 2” size, built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with jute twine, or built up with insulating cement, and finished to smooth hard surface, and covered with minimum 9 oz. per sq. yd. re-wettable glass cloth and jacket as specified for adjoining pipe.

I. For piping over 2” size, use manufacturer’s standard preformed insulation fittings for elbow, tee, etc., with jacketing as specified for adjoining pipe.

J. For pipes 1-1/2" and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

K. For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on hot and cold systems at pipe supports.

L. Where insulation covers unions, flanges, and equipment (valves, strainers, pumps, etc) that is anticipated to be removed for maintenance, the insulation shall terminate (mitered to the pipe) just prior to the aforementioned component with vapor barrier sealed tight to pipe. The tapered segment of insulation end shall not interfere with the removal of unions, flanges, flange bolts, or equipment. The component shall then be insulated with a removable wedge that seals tight to the adjacent insulation.

M. For pre-insulated pipe supports and insulation protection shields, refer to Division 23 Section Mechanical Supporting Devices.

N. For contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

O. Piping, fittings and valves not to be insulated:

1. Piping unions, control valves, balancing valves, strainers, and flexible connectors on hot water systems.
2. Control valves and balancing valves and any piping between control valve or balance valve and heating terminal device if valve is located within 1 foot of heating terminal device.
3. Valves furnished with removable insulation/jacket.
4. Heating hot water piping within terminal heating unit enclosures for cabinet unit heaters and fan coils.

P. Insulate around P/T test ports in such a way as to allow for easy access to ports without damage to insulation or vapor barrier.

Q. Provide complete insulation of chilled water piping system including unions, flange, and other piping specialties. Provide removable sections of insulation for devices for devices requiring regular maintenance access such as control valves, strainers, check valves, etc.

3.4 EQUIPMENT INSULATION

A. Apply insulation to equipment shells with bonding adhesive and wire in place. Fill joints and seams with insulating cement and cover insulated surfaces with wire reinforcing mesh. Apply additional coat of insulating cement, cover with glass fabric as specified herein, and finish to smooth hard surface.

1. Install removable insulation where access is required for cleaning, repair, and inspection, including chilled water pump heads and strainers. Construct removable insulation with Type A insulation for cold equipment. Do not apply bonding adhesive to equipment surface.

B. For equipment shells requiring vapor barrier, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric after application of insulating cement. For equipment shells not requiring vapor barrier, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric after application of insulating cement. Apply coating in accordance with manufacturer's recommended procedure.

C. Do not insulate over equipment nameplates or ASME stamps. Bevel and seal insulation at these locations.

D. Equipment not to be insulated:

1. Equipment furnished with factory insulation.

3.5 DUCTWORK AND COMPONENTS

A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcements and transverse connectors.

B. For support points of rectangular or oval ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 12" long with same thickness as insulation specified and shall be similar to HAMFAB H-block by ICA Inc or 6-pound density fiberglass board with 200 lb. / sq. ft. compressive strength at 10% deformation. Inserts shall be continuous under the entire width of the duct. Use Type RR, G, or PP insulation for inserts.

C. For support points of round ducts smaller than 16" diameter, weight-supporting insulation is not required for either rigid or flexible glass fiber insulation. Flexible glass fiber insulation may be installed outside of support for round ducts up to 16” diameter provided that vapor barrier integrity is maintained at rod penetration.

D. For support points of round ducts 16" diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" long with same thickness as insulation specified and shall be similar to HAMFAB H-block by ICA Inc or 6-pound density fiberglass board with 200 lb. / sq. ft. compressive strength at 10% deformation. Use Type RR, G, or PP insulation for inserts.

E. Secure flexible glass fiber insulation (Type F) to underside of horizontal rectangular or oval ductwork 24" in width or greater and on vertical sides of horizontal and vertical ductwork with mechanical fasteners not over 18" on center and within 3" of butt joint or edge.

F. Secure rigid glass fiber insulation (Type R) to all sides of horizontal and vertical rectangular or oval ductwork with mechanical fasteners. Install pins or fasteners as required to secure, but not less than 12" on center for underside and sides of ducts and 24" on center for top of ducts, and within 3" of butt joint or edge.

G. Pickle galvanized ductwork prior to applying adhesive for mechanical fasteners.

H. Where insulation is required for ductwork, provide insulation over entire ductwork system, including system components such as filters, mixing air chambers, sound attenuators, air measuring stations, reheat coils, etc. For fire dampers, smoke dampers and combination F/S dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation.

I. Provide insulation over supply air diffuser backpans and exterior of linear diffuser boots after termination point of flexible ducts or rigid duct insulation to prevent equipment from sweating.

J. Where vapor barrier jackets are specified, pins shall be jacketed over with matching material. Where staples are used for systems requiring vapor barrier, cover lap and staples with finish coat of lagging adhesive. Vapor seal insulation seams, punctures, and tears with two 4” wide coats of vapor barrier mastic.

K. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.

L. For other than factory-applied vapor barrier jackets, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For surfaces not requiring vapor barrier jackets, apply 2 coats of weatherproof mastic with glass fiber reinforcing fabric after application of insulation cement. Apply coating in accordance with manufacturer's recommended procedure.

M. D-1 jackets:

1. Butt together joints and seams firmly, cover with 3” wide ASJ tape.

N. D-2 jackets:

1. Butt together joints and seams firmly and cover with 3" wide FSK tape.

O. Ductwork not to be insulated:

1. Ductwork components with factory installed insulation
2. Concealed exhaust ductwork

P. Ductwork manual balancing damper (MBD) handles, airflow station pressure ports, access door handles, duct-mounted instrumentation, etc. shall be left exposed and / or accessible above the insulation vapor barrier to enable the TAB agency or engineering maintenance personnel to access, adjust and / or read these devices without disturbing the integrity of the insulation vapor barrier.

3.6 TYPE P OR PP INSULATION

A. Install Type P or PP insulation with specified insulation jacket in accordance with manufacturer's installation recommendations. Insulation shall be tightly butted and free of voids and gaps at joints. Use 3" wide tape at butt joints with minimum 1.25 times circumference wrapping.

B. Install pre-fabricated tight fitting insulation pieces on fittings, elbows, tees and valves.

C. Insulation at fittings and valves shall be the same thickness as on pipe section.

3.7 TYPE A INSULATION

A. Joints in insulation must face away from normal pedestrian walkways. All joints must be tightly butted and sealed with approved adhesive. Joints must be smooth and even. The use of thin tape of similar material to cover joints is not acceptance. Insulation must be cut straight with no uneven or jagged edges.

3.8 PAPER FREE JACKET (TYPE P-2 JACKET)

A. Circumferential joints shall be sealed with paper free butt strips that are compatible with EvolutionTM facing.

B. All penetrations of the EvolutionTM and exposed ends of insulation shall be sealed with a mold resistant vapor barrier mastic.

C. Mastic pipe section ends at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

END OF SECTION 230700

SECTION 230901 – CONTROL SYSTEMS INTEGRATION

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

C. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

D. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
2. American National Standards Institute (ANSI)
3. American Society of Mechanical Engineers (ASME)
4. American Society for Testing and Materials (ASTM)
5. American Refrigeration Institute (ARI)
6. EIA-709.1-A-99: Control Network Protocol Specification
7. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
8. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
9. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
10. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems
11. EIA-472: General and Sectional Specifications for Fiber Optic Cable
12. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
13. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
14. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
15. UL 916: Energy Management Systems
16. NEMA 250: Enclosure for Electrical Equipment
17. NEMA ICS 1: General Standards for Industrial Controls
18. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences
19. NFPA 70 National Electrical Code (NEC)
20. Instrument Society of America (ISA)
21. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
22. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
23. IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
24. LonMark International
25. BACnet Testing Lab
26. Occupational Safety and Health Act (OSHA)

1.2 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

1. Actuator: Control device to provide motion of valve or damper in response to control signal.
2. AI: Analog Input
3. AO: Analog Output
4. Analog: Continuously variable state over stated range of values
5. Auto-Tune: Software routine used to adjust tuning parameters based on historical data.
6. BAS: Building Automation System
7. BMS Building Management System
8. DDC: Direct Digital Control
9. DDCP: Direct Digital Control Panel
10. Discrete: Binary or digital state
11. DI: Discrete Input (Sometimes referred to as Binary Input BI)
12. DO: Discrete Output (Sometimes referred to as Binary Output BO)
13. EMCS: Energy Management and Control System (Typically interchangeable with BAS or BMS)
14. FA Field Adjustable
15. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
16. FLP Fail Last Position
17. FMS: Facility Management System linking two or more BAS
18. FO: Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
19. GUI: Graphical User Interface
20. HVAC: Heating, Ventilation, and Air Conditioning
21. IDC: Interoperable Digital Controller
22. ILC: Interoperable Lon Controller
23. Instrument: Device used for sensing input parameters or used for actuation.
24. LAN: Local Area Network
25. Modulating: Movement of control device through an entire range of values proportional to an infinitely variable input value.
26. Motorized: Control device with actuator
27. NAC: Network Area Controller
28. NC: Normally Closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
29. NO: Normally Open position of switch after control signal is removed or normally open position of manually operated valves or dampers.
30. Node: DDCP, operator workstation, or other control device connected to communications network.
31. Operator: Same as actuator for motorized devices. Also refers to an individual who physically "operates" facility.
32. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
33. PC: Personal Computer
34. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each share its database values with other devices connected to network.
35. P: Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
36. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (reset control).

37. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).
38. Point: Analog or discrete instrument with addressable database value.
39. Self-Tune: Same as Auto-Tune
40. Solenoid: Electric two-position actuator. (See E/P.)
41. TCC: Temperature Control Contractor (Same as Control Contractor)
42. TCP: Temperature Control Panel
43. WAN: Wide Area Network

1.3 ACCEPTABLE CONTROL CONTRACTORS

A. Control Contractor shall have full service office within 50 miles of project site. Full service office is defined as being home office of applications engineers, software engineers, supervisors, and field technicians, having complete parts inventory, and having required test and diagnostic equipment.

B. Contractor shall implement a Niagara based open system that will allow products from various suppliers to be integrated into a unified system to provide flexibility for expansion, maintenance, and service of the system. The University of North Carolina Wilmington shall be the named license holder of all software associated with all incremental work on the project. Only Niagara N4 with Energy Analytics software based products from:

1. Preferred Brand Alternate: Engineered Control Solutions (ECS) – Honeywell
2. Commercial Mechanical Systems (CMS) – Distech Controls
3. Schneider Electric (TAC)

C. Bids will be accepted only from prequalified Control Contractor per "Instruction to Bidders".

1.4 SYSTEMS DESCRIPTION

A. This project requires the installation of a new Integrated Automation System (IAS) constructed using a Tridium Niagara N4 Framework with LonWorks Field Level Devices. The new IAS shall utilize Tridium JACE controllers, networked with a Tridium Niagara N4 web supervisor compatible with the existing campus Tridium framework.

B. The Contractor will be required to perform the following:

1. The intent of this specification is to furnish and install a new Tridium Niagara N4 Framework with LonWorks fully programmable and application specific DDC controllers for the equipment identified in the contract documents.
2. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet, and Modbus. Non LonTalk communication protocol for specific pieces of equipment must be approved on a case by case basis.
3. The Tridium Niagara N4 Framework has drivers for BACnet, KNX/EIB, LonWorks, M-Bis, Modbus, oBIX, OPC, SOX, SNMP, OBIX, Z-Wave, etc. The contractor should utilize these drivers within the system design to minimize the use of third party gateways. The design documents should require the use of the drivers provided by Tridium to integrate existing or third-party systems. If any of these drivers are utilized the engineer must reference the appropriate drivers throughout the remainder of the specification sections.
4. Integrate the intelligent advanced meter data via LonWorks.
5. Provide Graphical User Interface Development for all the devices identified above.

6. Operator workstations connected to building Ethernet network shall be able to access BAS information as determined by Graphical User Interface (GUI) software through secure web access using browsing software (Internet Explorer, Mozilla Firefox, Opera, or Google Chrome). GUI software shall allow transparent access to each building component/system for control and/or monitoring.
7. The BMS server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the existing campus framework server.
8. All control devices furnished with this Section shall be programmable directly from the Operating System Server upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
9. Any control vendor that must provide additional BMS server software shall be unacceptable. Only systems that utilize the existing framework server shall satisfy the requirements of this section.
10. It is the contractor's responsibility to review all the design documents and specifications and report any discrepancies to the owner.

C. The existing campus Building Automation System is currently using a Tridium Niagara N4 Framework with LonWorks Field Level Devices.

D. New BAS shall seamlessly integrate with existing site Tridium Niagara N4 server operator interface. Existing web server shall be able to access and read all input, output and calculated points and issue commands to all output points in new BAS by means of a standard web browser. Contractor shall provide necessary hardware and software components to accomplish this interface.

E. Provide BAS architecture consisting of communication network, operator workstations, web servers and modular designed controllers with all points addressable and modifiable from operator workstations or from master controller using laptop computer. BAS shall be fully expandable with addition of hardware and/or software. Expansion shall not require removal of existing controllers, sensors, actuators, or communication networks.

F. System shall support operator workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.

G. Safety devices shall function in both auto and hand modes on starter, and on VFD in auto, hand or bypass modes.

1. Dampers interlocked with fans shall operate in both auto and hand modes to prevent dead-head of fans.
2. Valves interlocked with pumps shall operate in both auto and hand modes of operation to prevent dead-head of pump.
3. All safeties shall be hardwired through starter/VFD safety circuit to prevent unsafe operation when in either auto or hand modes.

H. Safety devices shall function in both VFD and bypass modes.

1. Dampers interlocked with fans shall operate in both VFD and bypass starter modes to prevent dead-head of fans.
2. Valves interlocked with pumps shall operate in both VFD and bypass modes of operation to prevent dead-head of pump.
3. All safeties shall be hardwired through VFD/bypass starter safety circuit to prevent unsafe operation when in either VFD or bypass modes.

1.5 OPERATOR TOOLS & USER INTERFACE

A. No workstation or head end computer is required.

B. Provide external hard drive that UNC W can use as a backup. The hard drive shall enough storage capacity to store all of the AHB software with 50% spare capacity available on the storage device.

1.6 SCOPE OF WORK

A. Provide all labor and materials for complete fully functioning control systems in accordance with Contract Documents included in this Section plus:

1. Section 230902 - Control Valves and Dampers
2. Section 230903 - Control Instrumentation
3. Section 230993 - Control Sequences

B. Engineering services shall be performed by Factory Trained Engineers. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's representative. Engineer reserves right to exclude Project Managers, Engineers, Field Supervisors, or Technicians whose experience is not sufficient to meet needs of Project.

C. Control Contractor’s Project Managers, Engineers and Digital System Programmers shall have previously performed in capacity that qualifies them to successfully engineer system of scope and magnitude similar to this Project.

D. Submit qualification of Project Managers, Engineers, Programmers, Field Supervisors, and Technicians to be assigned to this Project within 30 days after contract award. Use Qualification Form attached at end of this Section.

E. Labor shall include, but not be limited to:

1. Engineering services to size unscheduled valves and dampers based on design criteria specified in Section 23 0902 - Control Valves and Dampers and confirm sizing of scheduled valves and dampers.
2. Engineering services to produce requested submittals and working construction drawings and record drawings as specified here within.
3. Engineering services for required software programming.
4. Engineering services for graphics programming specified.
5. Engineering services for BAS Ethernet network design.
6. Project management services as single point contact to coordinate construction related activities.
7. Field mechanics for installation of control wiring and related control devices.
8. Field technicians to startup, calibrate, adjust, and tune control loops.
9. Field technicians to perform system checkout and testing, and to complete required reports.
10. Field supervisor during controls installation and startup.
11. Field technicians to assist Mechanical Contractor and Testing and Balancing (TAB) Contractor in adjusting controls and determining setpoints related to TAB work.
12. Field representatives and/or classroom instructors to provide Owner training as specified.

F. Mechanical Contractor shall provide wells, taps, and other mechanical interfaces required for control equipment mounting into piping systems. Mechanical Contractor shall install in-line mounted devices, such as valves, dampers, flow meters, static pressure probes, etc., furnished by Control Contractor. Control Contractor shall be responsible for installation of other control devices, such as actuators, linkages, sensors, air terminal controllers, flow transducers, remote mounted control devices, control panels, control transformers, etc.

G. Control Contractor shall be responsible for complete installation of control devices (except as noted) and wiring terminations at controller locations to accomplish control sequences specified in project manual or on drawings. Control Contractor shall also be responsible for additional instrumentation described in point schedules found in Contract Documents, which may not be directly related to specified control sequences. Electrical work required as integral part of control work is responsibility of Control Contractor.

1. Electrical Wiring (120V and 24V):
   a. Electrical Contractor will provide circuit breakers designated for use by Control Contractor to provide electrical power to controllers.
   b. Control Contractor is responsible for providing final power connections from appropriate electrical distribution panels to all control devices, including conduit, wire, and/or disconnect switches.
      1) All controls circuits for equipment connected to the emergency generator shall be fed from power circuits which are also connected to the emergency generator.
   c. Control Contractor shall provide 120 to 24 VAC transformer panels for air terminal controllers and other field mounted devices that require 24 VAC, 60 hertz connection. Control Contractor shall provide electrical disconnect upstream of and adjacent to each transformer.
   d. Should any change in number of controllers or addition of other electrical equipment after Contracts are awarded, Control Contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of Control Contractor.
   e. Coordinate with Electrical Contractor for additional power requirements.
2. Device Tagging:
   a. Control contractor shall provide unique tag numbers for all devices under this specification and reference those tag numbers in control sequences and control diagrams.
   b. If Owner has tagging convention, Control contractor shall utilize it. If no tagging convention exists, Control contractor shall provide one for all devices under this specification.

H. Fully functioning BAS Ethernet network, including all hardware (horizontal network cabling, routers, switches, firewalls, patch panels, patch cords, cabinets, etc.), as required for the BAS

I. Provide temporary Ethernet network for communications between Ethernet-based controllers and BAS servers (Web & Data Historian) until building IT network is available for use by BAS. Temporary Ethernet network and all other communications required for BAS shall be installed as required for specified operation of mechanical equipment to allow check out and commissioning of equipment in timely manner.

J. Control Contractor shall be responsible to provide additional BAS data drops (from telecommunication room patch panel to field jacks/patch panels) that are not accounted for in the contract documents. Coordinate final Telecommunications room patch panel connections with network installation Contractor.

K. Control Contractor shall be responsible for maintaining master IP address list for all BAS devices throughout project to be handed over to Owner upon completion.

L. Materials shall be as specified unless approved through procedures for product substitution specified in Division 01. Control Contractor shall provide components not specifically indicated or specified, but necessary to make system function within the intent of specification.

M. If during the installation period any of the factory equipment or material provided in the system is found to be defective in material or workmanship, it shall be replaced or repaired by Contractor at no additional cost to the Owner within 24 hours from the time the problem was reported/discovered.

N. Any part/device or equipment installed as part of this contract found to be malfunctioning or defective during the warranty period shall be replaced by Contractor within 24 hours from the time the problem was reported.

O. Electrical products shall be listed and labeled by UL and comply with NEMA Standards.

P. All controls and wiring used for smoke control/life safety shall be UL 864 UUKL rated.

Q. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.

R. Provide tamper resistant screws and fasteners for equipment located in accessible and/or public areas.

S. Contractor is responsible for integration of the following independent systems into BAS:

1. Electrical Metering:

   a. Electrical Metering provider will provide Modbus TCP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly to all suppliers listed in Division 26 for Electrical Metering. Control contractor and Electrical Metering provider are responsible for coordination of integration, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, Section 26 2400 Switchboards and Section 26 2713 Electrical System Metering for programming and monitoring requirements.

2. Water Metering:

   a. Water Metering provider will provide Modbus TCP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly to all suppliers listed in Division 23 for Water Metering. Control contractor shall provide Water Meter and is responsible for coordination of integration, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, Section 22 1100 Water Distribution System for programming and monitoring requirements.

3. BTU Metering:

   a. BTU Metering provider will provide Modbus TCP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly to all suppliers listed in Division 23 for BTU Metering. Control contractor shall provide BTU Meter and is responsible for coordination of integration, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, Section 23 0903 Controls Instrumentation for programming and monitoring requirements.

4. Fire Alarm System (FAS) Monitoring:

   a. FAS provider will provide contact termination points and/or addressable relays for connection to BAS for Smoke Control and Equipment Shutdown. Contractor shall supply cabling, conduit, and hardware necessary to make connections from BAS to FAS. Contractor and FAS provider are responsible for coordination of testing point connections between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules and Control Sequences for programming and monitoring requirements.

5. Variable Frequency Drives (VFD):

   a. VFD provider will provide a termination point for a single point communication connection to the BAS utilizing LonWorks MS/TP protocol. Contractor shall provide cabling and conduit to make an interface connection from the BAS to the VFD. Control contractor shall provide all stand-alone VFDs (i.e. VFDs not directly manufactured as part of the controlled equipment). Control contractor and VFD provider are responsible for translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules, and Section 23 0515 Variable Frequency Drive (VFD) System for programming and monitoring requirements.

6. Variable Refrigerant Flow System (VRF):

   a. VRF provider will supply a termination point for a single point connection to BAS. Control contractor shall supply cabling, conduit, and hardware necessary to make an interface

connection to the VRF point of connection. Control contractor is responsible for a BAS solution to communicate data directly to all suppliers listed in Division 23 for VRF bidders. Control contractor and VRF provider are responsible for coordination of integration requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to Section 23 8127 Variable Refrigerant Flow System Equipment for programming and monitoring requirements.

7. Split-System Air-Conditioning Equipment

   a. Split-System Air Conditioning Equipment provider will provide connections(s) to BAS. Control contractor shall supply cabling, conduit, and hardware necessary to make an interface connection to the Split-System point of connection. Control contractor is responsible for a BAS solution to communicate data directly to all suppliers listed in Division 23 for Split-System bidders. Control contractor and Split-System provider are responsible for coordination of integration requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, DDC Point Schedules, and Package A Section 23 8126 Split-System Air-Condition Equipment for programming and monitoring requirements.

8. Humidification Equipment

   a. Humidification Equipment provider will provide connections(s) to BAS. Control contractor shall supply cabling, conduit, and hardware necessary to make an interface connection to the Steam Generator point of connection. Control contractor is responsible for a BAS solution to communicate data directly to all suppliers listed in Division 23 for Humidification Equipment bidders. Control contractor and Humidification Equipment provider are responsible for coordination of integration requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, DDC Point Schedules, and Section 23 8413 Humidification Equipment for programming and monitoring requirements.

9. Domestic Water Recirculating Pumps:

   a. The domestic water recirculating pumps are 100% redundant and operate in a run / standby mode.
   b. BAS will equalize run time by alternating each pump on 12 PM Sunday (field adjustable).
   c. BAS will monitor pump status with CTs. If the pump commanded to operate fails to start or fails while operating, the standby pump will automatically start, and a pump failure signal will register with the BAS.

1.7 SUBMITTALS

A. Extended Service Agreement:

1. Control manufacturer shall, upon completion of warranty period, make available to Owner annual service agreement covering all labor and material required to effectively maintain control system after warranty period. Owner reserves the right to accept or reject any such offers and to cancel on-going agreements with 30-day written notice.
2. During extended service period, Contractor shall maintain Operation and Maintenance manuals to reflect all changes made to BAS.

B. Shop Drawings:

1. Submit manufacturer's printed product data sheets for control devices and materials listed in bill of material in Control Contractor's control drawings. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing each device manufacturer and full model number with links to device pages. Organize sheets in order of

model number, alphabetically, then numerically. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Data sheets shall include sufficient technical data to describe instrument parameters required as specified.

2. Submit data concerning type of signal wiring and installation methods including raceway types and grounding methods.
3. Submit control drawings in pdf format with bookmarks provided for each system and table of contents with links to each page. Control drawings shall include, but are not limited to, the following:
    a. Overall system/network architecture drawings: Provide block diagram showing relationship of each controller, control panel, or other network devices relative to each other. Label room location of each device. Number and indicate model number of each device. Indicate network types.
    b. Control Drawings: Including graphic representation of systems with major in-line components to properly locate all control devices. Identify controlled devices with their software designation on drawings, including unique valve and damper tag numbers.
    c. Detailed wiring and piping diagrams showing point-to-point hookup details of transducers, relays, outputs, inputs and subsystem components. Label control wires with field ID numbers/colors.
    d. Bill of material identifying actual product model number used for each control device for each schematic control drawing.
        1) Bill of material shall be included on flow diagrams for each system and on panel layouts showing panel components.
    e. Drawings showing proposed locations of sensors and flow meters in ductwork and piping systems.
    f. Sequence of operation: Provide written narrative describing each control sequence indicating method of control. Identify sensors, controllers, and actuators used with references to tag number of controlled device. Include set points of each control loop.
4. Control Instrumentation (23 0903) submittals can be submitted as separate submittals from control shop drawings but must be submitted simultaneously with control shop drawings.
5. Submit a sample graphic user interface screenshot for each type of equipment listed above. Graphic User Interface should be consistent with existing campus architecture.
6. All graphics will be reviewed and approved by engineer and UNC W.

C. Completion Checklist:

1. Submit with shop drawings, detailed completion checklist including written procedures for adjusting and calibrating each type of instrument and sensor. Engineer reserves the right to request modifications to any procedure, which is incomplete or not adequate to prove system performance.
2. Checklist shall include references to the following additional requirements:
    a. Instruments and sensors shall be calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing.
    b. Each point shall be checked for calibration, connection to correct control loop, and proper setting of limit and alarm values.
    c. Transducers and other output devices shall be properly zeroed and calibrated at both minimum and maximum output. Document settings for discrete instruments and set points for analog instruments shall include minimum and maximum positions for safe operating conditions where applicable (max. pump speed or max. frequency of fan drive, etc.).
    d. Control loops shall be tuned to maintain controlled process variable at set point through seasonal conditions without operator intervention. Provide multiple sets of tuning parameters if necessary. Controller shall automatically use tuning parameters appropriate to existing ambient conditions. Maintain record on completion checklist, of control loops that require tuning at alternate times of year. Instruct technicians to supply default parameters

that can approximate stable control until actual load conditions allow proper tuning of control loops.

e. Performance tests of analog control loops shall be performed by changing set points and verifying that sequences can come into stable control within reasonable time period appropriate for each sequence. Simulate load changes for pressure and flow control loops.

f. Performance tests of discrete control loops shall be performed by adjusting set point and verifying sequence action.

g. Alarms, including network failures, shall be tested for each controller and device connected to network. Ensure that alarms are properly acknowledged at operator's workstation.

h. Schedules for each system/device shall be verified.

i. Graphics shall be verified for functionality including password protection, floor plan displays, system displays, alarm messaging, historical trends, report generation and HVAC schedules.

j. BAS Ethernet network testing and benchmarking documentation showing network performance from switch to switch.

k. Testing of BAS to ensure cyber security. Coordinate testing requirements with Owner.

D. Control Contractor and Mechanical Contractor shall walk proposed static pressure sensor and flow meter locations and mark up drawings for review and approval by Owner and Engineer prior to installation.

E. Submit documentation indicating LONMARK® compliance and include Protocol Implementation Conformance (PIC) Statements. All PIC statements, product literature, and standard configuration parameters shall be compiled and submitted on electronic media, in addition to providing hard copies.

1. Niagara N4 Network Controllers
2. Sensors and Actuators
3. Application Specific Controllers
4. Programmable Control Units
5. Interface Panels
6. Network Management Equipment (Routers, Protocol Analyzers, etc.)

1.8 WARRANTY

A. Warranty period shall begin as authorized by the Owner's representative in writing. Authorization will not be given before the following conditions are met:

1. All verified completion checklists provided to Owner.
2. Completion of all punch list items.
3. Conduction of a preliminary training session for personnel. The training shall consist of an orientation session at the job site to familiarize the personnel with the location and type of controlled equipment and controls on the project, a discussion of the control sequences, and a review of the control drawings.
4. Completion and distribution of the as-built control drawings, including correction of all items noted by Owner and Engineer after review of the documents.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. A telephone number where the service supervisor can be reached at all times shall be provided. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

D. This warranty shall apply equally to both hardware and software.

E. Service personnel shall be qualified to accomplish work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

F. Scheduled Inspections:

1. Two inspections shall be performed prior to warranty expiration and all work required shall be performed. Inspections shall be scheduled 6 months after Owner acceptance and one month prior to end of warranty period.
2. These inspections shall include:

   a. Visual checks and operational tests of equipment.
   b. Clean control system equipment including interior and exterior surfaces.
   c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.
   d. Run system software diagnostics and correct diagnosed problems.
   e. Resolve any previous outstanding problems.
   f. Install software upgrades, patches and fixes. Contractor to provide verification to facility personnel that all upgrades, patches and fixes to be installed have been tested in accordance with site testing and deployment procedures.

G. Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.

H. Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

I. Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

J. Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

K. During the warranty period, the Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever the Contractor makes a change to the software. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge.

L. At the end of the warranty period, the Contractor shall provide updated copies of the latest versions of all project record documentation as described in Paragraph 1.10, Record Documents. This includes final updated drawings, software documentation, and electronic media backups that include all changes that have been made to the system during the warranty period.

1.9 COORDINATION WITH TAB CONTRACTOR

A. Control Contractor shall allow sufficient time to aid and instruction to TAB Contractor in proper use and setting of control components such as, Operator Workstation computers, static pressure controllers, "K" Factors for VAV boxes, or any other devices that may need set points changes so that TAB work can be performed.

B. Provide required hardware and software related to control system to TAB Contractor to allow testing of systems and continued operation.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements.

B. Operation and Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. Descriptions shall include:

1. Product manuals for the key software tasks.
    a. Operating the system
    b. Administering the system
    c. Engineering the Operator workstation
    d. Application programming
    e. Engineering the network
    f. Setting up the web server
    g. Report creation
    h. Graphics creation
    i. Data backup & Archiving
2. List of recommended maintenance tasks associated with the system, controllers, instruments, operator workstations, data servers, web servers, and web clients.
    a. Define the task.
    b. Recommend a frequency for the task.
    c. Reference the product manual that includes instructions on executing the task.
3. Licenses, guarantees, and warranty documents for equipment and systems.
4. System architecture diagram for components within the building annotated with specific location information.
5. As-built drawing for each control panel
6. As-built wiring design diagram for each control panel
7. As-built system flow diagram for each system
8. Sequence of control for each system
9. Binding map for the building
    a. A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.
    b. Include:
        1) Description of the variable
        2) Sending device
        3) Receiving device
10. Product data sheet for each component
11. Troubleshooting guide
12. Repair parts list
13. Calibration instructions
14. Control Contractor's completion checklist

15. Manufacturer representative's name, address, and phone number

1.11 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements.

B. Submit revised shop drawings indicating changes made during Project.

C. Record drawing submittals shall be inclusive of BAS as installed and commissioned.

D. Update control diagrams to include tuning parameters and set points applicable to systems depicted as of date of system completion. This information shall be incorporated with sequence of operation for each system.

E. Include floor plans showing location of control panels and routing of BAS network cabling.

F. List of all IP addresses assigned on IFMS complete with description of device and associated vendor.

G. LonWork systems and devices:

1. Submit finished device addressing documentation.
2. Submit finished hardcopy of device binding database.

H. Provide passwords, if used, for back-up and restore functions for each controller.

I. Software (as installed and commissioned)

1. All software submittals shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided as part of the BAS.
2. Submit a copy of all software installed on the servers and workstations.
3. Submit all licensing information for all software installed on the servers and workstations.
4. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
5. Submit all licensing information for all of the software used to execute the project.
6. All software revisions shall be as installed at the time of the system acceptance.

J. Firmware Files (as installed and commissioned)

1. All firmware files shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided in the BAS.
2. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
3. Submit control listing of firmware version for all firmware that is permanently burned on a chip at the factory.
4. Submit a copy of all application files that were created during the execution of the project.
5. Submit a copy of all graphic page files created during the execution of the project.
6. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. Owner shall retain all rights to software for this project.

B. Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use on the Owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of Owner. These include but are not limited to:

1. Server and Workstation software
2. Application Programming Tools
3. Configuration Tools
4. Addressing Tools
5. Application Files
6. Configuration Files
7. Graphic Files
8. Report Files
9. Graphic Symbol Libraries
10. All Documentation.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Control wiring shall be in accordance with National Electrical Code and Local Electrical Codes. Final connection points at devices and panels shall be made either at terminal blocks integral to device or at separate terminal blocks mounted inside of control panel enclosures. Use of wire nuts and crimped connections are not allowed for terminating control wiring unless approved by Engineer.

B. Refer to Division 26 for specification requirements for conduits and conductors, except as noted.

C. Terminal Blocks:

1. Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

D. Signal and Power Conductors (24 V and Under):

1. Wires smaller than 1.0 mm2(#18 AWG) shall not be used, except for manufacturer supplied instrument specific wire, or where otherwise specified. Use 2-wire stranded twisted/shielded pair 24 VDC for analog and discrete input and 24 VAC/VDC output devices. For 3-lead RTD signal wiring, use 1.0 mm2(#18 AWG) stranded, tinned copper twisted/shielded 3-conductor. Provide isolated instrument grounding system as per manufacturer's recommendations.
2. Conductors not concealed in raceway shall have UL Listed plenum rated Teflon insulation.
3. Provide 250-ohm, 5-watt, 0.1% tolerance dropping resistors in 4 - 20 mA circuits as required to generate 1 to 5-volt signals in 24 VDC powered instrument loops.
4. 24 VAC Power Conductors shall be 1.0 mm2(#18 AWG) 2 wire twisted pair or larger. Provide Metal Oxide Varistors (MOVs) on 24 VAC/VDC discrete outputs connected to inductive loads to reduce noise levels (i.e., solenoid valves, motor contactors, relays, damper/valve electric actuators, etc.).

5. Stranded twisted/shielded control conductors are required with shields to be terminated within variable frequency drive (VFD) enclosures to reduce effects of noise from VFD. Follow VFD manufacturer's installation instructions for wiring control conductors to VFD.

E. Communication Cable:

1. Cable not concealed in raceway shall have UL Listed plenum rated insulation.
2. Floor Level Network Communication Cable (Twisted Pair): Use control system manufacturer's standard communications cable or 0.35 mm2(#22 AWG) to 0.20 mm2(#24 AWG) twisted, shielded pairs, coaxial cable, or fiber optics for communications between remote controllers/devices
3. Interior LAN Horizontal Communication Cable:
   a. Refer to specification 27 1500 - Communications Horizontal Cabling.
   b. Horizontal copper LAN cable shall meet or exceed all requirements of Category 6 cable as specified in TIA/EIA-568-B.2.
   c. BAS Ethernet network Horizontal copper LAN cable shall be yellow.
   d. Horizontal copper LAN cable shall be terminated in an eight-position modular Jack with color to match system cable.
   e. Horizontal copper LAN cable shall be terminated in a telecommunication room that is on the same floor as the area being served in a 4-pair 100Ω twisted pair modular patch panel with color to match system cable.
   f. Horizontal copper LAN cabling shall not exceed 295 ft.
   g. Provide minimum of 10’ of slack at telecommunication room and 12” of slack at outlet

F. Transient Voltage Surge Suppression Devices:

1. Devices shall be designed for 120 V power conditioning devices for electronic equipment. Devices shall be designed, manufactured, tested, and installed in compliance with ANSI/IEEE C62.41 and C62.45, Federal Information Processing Standards Publication 94 (FIPS PUB 94), NEMA, NFPA 70, 75, and 78, and UL 1449 and 1283. Devices shall be labeled for UL 1449.
2. Clamping voltage for 120 V power systems shall be 400 V.
3. Provide visual indicator of when surge device has been used.

G. Uninterruptible Power Supply

1. Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal
2. Provide UPS for backup power for the entire Building Automation System, including Operator Workstations, Building Level Controllers, Floor Level Controllers, Special Collections Temperature / Airflow Controls, miscellaneous field panels and all devices connected to controllers and panels. UPS shall maintain control upon loss of normal power and until emergency/standby power supply is brought on line.
3. Select UPS for minimum of 5 minutes backup time for load connected. This will allow emergency/standby power sources to come on line and provide backup power to emergency/standby powered equipment.
4. Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.
5. Operating Parameters:
   a. Operating Temperature: 32°F to 104°F
   b. Relative Humidity: 0 to 95% rh, non-condensing
   c. Recharge Time: 8 hours, typical
6. UPS shall have self-diagnostic capability with DO to BAS to allow remote monitoring/alarming of UPS trouble or alarm conditions.

H. Control panels shall meet the following minimum requirements:

1. Outdoors: Control panels located outdoors shall comply with NEMA 3R or 4X requirements.

2. Mechanical Rooms: Control panels located in mechanical or electrical rooms shall comply with NEMA 4 requirements.
3. Other Locations: Control panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.

I. Local control panels shall be constructed of steel or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color. Construction shall comply with NEMA 1 Standards for interior panels, NEMA 3R for exterior panels.

2.2 NETWORK HARDWARE

A. Ethernet Switches, Routers, and Bridges:

1. Network hardware shall be provided and configured to form a campus-wide Fast Ethernet (a combination of 100BASE-TX and 100BASE-BX, -FX, and –SX or higher).
2. Ethernet devices shall be IEEE Std 802.3 which shall function as the center of a distributed-star architecture and shall be "learning" type with spanning tree algorithms per IEEE Std 802.1D. All devices shall have a non-blocking architecture.
3. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.
4. Network hardware shall be compatible with the copper and fiber optic cabling installed by the Division 27 contractor. Refer to specifications 27 1300 and 27 1500 for media types.
5. Switch located in BAS server rack shall be managed type and shall have a minimum of two fiber optic ports.
6. Switch shall include N.O./N.C. alarm contact for monitoring by BAS.

B. Network Components:

1. Network components (Racks, enclosures, patch panels, etc.) shall comply with respective sections of specification 27 1100 – Communications Equipment Room Fittings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment and wiring in neat and workmanlike manner.

B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install devices such as immersion wells, pressure taps, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, valves, dampers, and other such items furnished by Control Contractor, which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. All BAS associated 120 VAC power wiring (including all input and output power supplies) shall originate from clearly-marked, BAS-dedicated circuit breakers. All input/output transducers shall be powered from the same circuit that supplies power to the associated BAS controller. All BAS equipment shall be fused in accordance with manufacturer's recommendations.

E. 120 VAC power shall not be allowed inside BAS controller panels. All 120 VAC to 24 VAC transformers and 120 VAC to 24 VDC power supplies shall be located in enclosures adjacent to the control panel being served. Terminal unit controls shall be served by consolidated 24 VAC transformer panels.

F. BAS controllers shall be labeled with the source of electrical power including panel number, circuit breaker number, and room number where electric panel is located.

G. Devices containing mercury are not allowed.

H. Coordinate mounting height and location of control devices so that NEC workspace clearances are maintained.

I. During construction, Contractor shall take necessary precautions to ensure all panels, wiring, instrumentation, etc. are kept clean and dry. Upon Project completion, control panels shall be clean of wire nuts, trash, and wire stripping. All excess material is to be turned over to Owner BAS group.

J. BAS floor level network to room/equipment controllers shall be confined to the same floor the respective building level controller is located on.

1. In applications where the floor level network must transition between floors, the transition shall be located in a clearly marked junction box on each floor of appropriate size to accommodate a screw terminal strip. Network cabling shall be labeled to indicate the previous connection prior to entering the junction box with the terminal strip. Terminal strip shall be used as a transition point from one floor to the next. Terminal strip shall be large enough to accommodate transitions to and from the floors below and above if floor transitioning is required.

K. Labels and tags shall be keyed to unique identifiers shown on As-Built drawings. Enclosures and DDC Hardware and controllers shall be labeled. Sensors, valves and actuators shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Duct static pressure taps shall be tagged at location of pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.

3.2 CONTROL WIRING

A. Provide electrical wiring required for complete functional control systems, including power circuit to control panels, both line and low voltage, in accordance with applicable local codes, and latest version of National Electrical Code and NFPA. Refer to Paragraph 1.6.H. for definition of scope of Work.

1. Voltage drops for all low voltage circuits shall be calculated prior to installing low voltage circuits. Voltage drop calculations shall be made available to Engineer on demand.

B. Control panels serving equipment fed by emergency/standby power shall also be served by emergency/standby power. Equipment fed by emergency/standby power is so indicated on mechanical equipment schedules and electrical motor schedules. Control panels shall be powered by local UPS (Uninterruptible Power Supply) to ensure continued control of equipment powered by site standby power sources when primary power source is lost. Devices such as Operator Workstations, Floor Level and Building Level Controllers, and Application Specific Controllers shall be provided with UPS power.

C. Where multiple controllers reside in a single control panel, provide a separate disconnect (or fuse) for each controller.

D. Power wiring to control compressors and dryers will be provided by Electrical Contractor. Furnish field-mounted starters to Electrical Contractor for installation and supervise installation.

E. Install control wiring in metal conduit or raceway system. Refer to Division 26 - Electrical for additional requirements.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 0000 – General Electrical Requirements.

G. Color-code each junction box cover plate as to signal type using 13 mm(1/2") self-adhesive color dot or enamel spray paint. Use green for low voltage signal wiring and yellow for line voltage wiring used for signal wiring or dedicated power wiring.

H. Tag each wire termination at control panels, junction boxes, and remote control devices with unique wire ID number.

I. Low voltage wiring concealed above accessible ceilings does not require raceway. Cables not in raceway shall be routed along building structure lines using Bridal Rings, J-hooks or other mounting methods as approved by Engineer. Use of wire-ties for attaching cabling to duct brackets, piping or structure is not acceptable. Diagonal routing is not allowed. Label each cable not in raceway with unique wire ID number every 15 m(50 ft).

J. Terminate low voltage DC instrument signal cable with black terminated on positive terminal and white terminated on negative unless otherwise noted.

K. Run direct current instrument conductors separately from alternating current conductors. Where allowed by NEC wiring classification, AC-DC route crossings shall be at 90 degrees. Install special sensor to transmitter cables in accordance with manufacturer's installation drawings or in compliance with manufacturer's instructions. Extra precautions shall be taken when pulling and shortening these "vendor furnished" cables. Any extra length on these cables shall be neatly coiled into minimum 80 mm(3") diameter coils and installed into junction box.

L. All wiring terminating in a control panel/enclosure shall be landed on terminal strips, with one wire per terminal. All I/O points on a DDC/BAS controller shall be wired to panel-side of terminal strip, including all spare I/O points.

M. All communication/power/signal wiring terminating in a control panel/enclosure/junction box shall be provided with a minimum of 3” – 6” extra wiring length. Extra cable shall be loosely folded/looped and stored neatly in wireways or cable tray/headers above control panel.

N. Route intrinsic safe wiring separately from other conductors. These conductors shall not be run with, nor cross, conductors of other NEC classifications and shall require intrinsic barrier if run in the same path with wiring of other classifications.

O. Follow Owner’s standard cabling color codes when specified and different than those specified below.

P. Suggested instrument and control conductor cables and color codes are as follows:

Type	Configuration	Colors	Manufacturer Part No.
120 VAC, 2.50 mm2(14 AWG)	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9411
120 VAC, 2.50 mm2(14 AWG)	3 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Gray PVC	Belden 9495
24 VAC, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED	Belden 89740

Type	Configuration	Colors	Manufacturer Part No.
		Jacket - Red FEP	
24 VAC, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Analog Input, 1.0 mm2(18 AWG)	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Input, 1.0 mm2(18 AWG)	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Input, 1.0 mm2(18 AWG)	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Analog Input, 1.0 mm2(18 AWG)	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Analog Output, 1.0 mm2(18 AWG)	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Output, 1.0 mm2(18 AWG)	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Output, 1.0 mm2(18 AWG)	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Analog Output, 1.0 mm2(18 AWG)	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Discrete Input, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Input, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Output, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 1.0 mm2(18 AWG)	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Discrete Output, 1.0 mm2(18 AWG)	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A

Type	Configuration	Colors	Manufacturer Part No.
General Purpose, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
General Purpose, 1.0 mm2(18 AWG)	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
General Purpose, 1.0 mm2(18 AWG)	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
General Purpose, 1.0 mm2(18 AWG)	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Intrinsically Safe Control Cable, 1.5 mm2(17 AWG)	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Light Blue PVC	Anixter BL0012650
Intrinsically Safe Control Cable, 1.5 mm2(17 AWG)	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Light Blue PVC	Anixter BL0012651

Q. Electric Signal Cables:

1. Analog electric signal cables from electronic transmitters to controllers/receivers and from controllers to other analog devices shall be continuously shielded to reduce effects of EMI on control signals residing on those cables. Electric signal cables to discrete devices typically do not require shielding, but for better noise immunity use twisted/shielded pairs.
2. Shields shall be grounded at power source end only and floated at other end. Pay particular attention to floating shields through termination points, maintaining only one single grounding point, and insulating from ground at other points.
3. Provide 250 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 1 - 5 VDC signals or 500 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 2 - 10 VDC signals from 4 - 20 mA control loop powered by 24 VDC power supply.

R. BAS Network Communication Cable:

1. Install special cable connectors in accordance with BAS manufacturer's recommendations.
2. Typically, 0.35 mm2(#22 AWG), but no smaller than 0.20 mm2(#24 AWG), twisted pairs, twisted shielded pairs, coaxial cable, fiber optics or manufacturer's standard cabling for communications between remote control devices and BAS controllers.
3. BAS Network communication cable shall not be spliced.
4. Provide isolated instrument grounding system as necessary per manufacturer's recommendations.

3.3 LOCAL CONTROL PANELS

A. Provide local control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served.

B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 1.8 m(6 ft) above floor. Install panels so front cover door can swing fully open without interference.

C. Label local control panels with respective unique ID numbers in accordance with Section 23 0553 - Mechanical Identification.

D. All control panels located in accessible areas to be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.

E. Panel Layout:

1. Locate controllers in lower half of panel first and upper half second.
2. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.
3. Provide separate enclosure for 120 VAC power transformer and circuitry.
4. Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.
5. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.
6. Do not place controller or control devices on enclosure sides.
7. Do not use any control panel as wire or cable pass-through to adjacent panel.

3.4 BAS ETHERNET NETWORK TESTING AND BENCHMARKING

A. Test and document connectivity, latency, and integrity of network from each switch to each BAS controller and BAS server switch and from switch-to-switch.

1. Latency between any ports shall be equal to or less than 1 millisecond.
2. Packet loss shall be less than 0.5% between any ports when tested with frame sizes between 64 and 1518 frames for duration of 60 seconds.

B. Test and document all telecommunication protection/security techniques employed on system including access control into BAS Ethernet network from other building networks and access control to other building networks from BAS Ethernet network. Coordinate testing procedures with Owner.

3.5 ADJUSTMENT AND COMPLETION CHECKLIST

A. After completion of installation, follow checklist procedure defined in checklist submittal to adjust and calibrate thermostats, control valves, control actuators, controllers, sensors, and other equipment provided in this Contract. Include signed and dated, completed checklist in Operation and Maintenance Manuals.

B. Upon completion of Work but before final acceptance of systems, Engineer or Owner's representative will verify performance of control loops. Control Contractor shall immediately remedy any deficiencies found. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program. Corrective modifications made by Control Contractor during warranty period shall be incorporated and updated in Operation and Maintenance Manuals.

C. After final acceptance of system, Contractor shall work with Owner to remove all existing user names and passwords for all software and hardware used on project and create new user names and passwords as required.

3.6 OWNER TRAINING

A. Provide full time BAS operator to run system after systems have been started and are regularly used until Owner has completed on-site training specified.

B. Provide minimum of 24 hours of comprehensive training in two separate sessions on-site (48 hours total) to Owner's representatives. Conduct training sessions during normal business hours after system start-up and acceptance by Owner. Scheduling of training session(s) will be established by Owner. Portions of training may be performed before system is completely operational, but no sooner than one month before system is planned to be fully operational. Final training session shall be held after systems are complete including all graphics programming.

C. Course content shall include, but not be limited to, the following topics:

1. Explanation of control sequences. Include which sensors are used and how output device operates.
2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3. Walk-through of Project to identify controller locations and general routing of network cabling.
4. Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
5. Review of operation of operator's workstation; include hardware (PC's, printers, etc.).
6. Review of operator's workstation software using specific examples of operating hardware.
7. Review of portable operator's workstation software using specific examples of operating hardware.
8. Any additional item(s) specifically requested by Owner.

D. Provide listing of regularly scheduled factory classroom training sessions concerning advanced topics covering proper operation and maintenance of control systems, sensing, monitoring and control equipment. Additional classes travel and lodging will be arranged and paid by Owner.

E. Provide minimum of 8 hours of additional on-site training to Owner's Representatives, 6 months after initial training is completed.

F. Scheduling of training session(s) will be established by Owner.

END OF SECTION 230901

Qualification Form	
Brief resume of key persons, specialists, and individual consultants anticipated for this project:	
a. Name & Title:	b. Project Assignment:
c. Name of Firm with which Associated:	d. Years of Experience: With this Firm_____ Other firms_____
e. Education: Degree(s)/Year/Specialization	f. Responsibility Level Proposed for this Project:
g. Other experience and qualifications relevant to the proposed project (include training courses/certifications):	
Recent Relevant Experience (see example below) ▪ Company, Location - Name of Specific Project, Facility - Description of Work and Responsibilities	Qualifications

SECTION 230902 - CONTROL VALVES AND DAMPERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include all charts, graphics or similar items used in making selections including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differential.

B. Submit valve schedules with shop drawings which indicate unique tag numbers for each device, equipment or system served, device model numbers, sizes, shutoff head required, actuator air pressure or force required to meet shutoff head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper shop drawing submittals will not be processed unless all supporting data and sizing calculations are included.

D. Submit damper schedules with shop drawings which indicate unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials in which they are installed (galvanized steel, aluminum, 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized ductwork.

1.2 VALVE SELECTION AND SIZING

A. General:

1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°F and all modulating butterfly valves over 60°F.
2. Select control valves and actuators for 100% shutoff against system's maximum differential pressure. (Maximum pump head at no flow condition for water systems in coupled mode).
3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in the systems.
4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
5. Shutoff and two-position valves shall be full pipe size.
6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system being installed. Valve calculations shall include information such as pump head or available pressure.
7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Instrumentation Valves:

1. Unless otherwise noted, instrumentation shut off valves for isolation of gauges, switches, transmitters, etc. shall be as follows:

   a. Water systems globe type valves
   b. Ductwork, air handling unit or terminal device penetrations: ball or plug type valves
   c. Liquid line sampling valves: multiple turn, metering type valves.

C. Water Valves:

1. Select modulating control valves to provide 3-5 psi pressure drop at design flow rate.
2. Design criteria for sizing modulating valves shall be based on 2 port, fail open, equal percentage valves unless otherwise specified. Select heating control valves for minimum of 25% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve. Select cooling control valves for minimum of 10% of equipment subcircuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balance valve.
3. Select control valves based on pressure drop calculations based on Cv values at 100% stroke.
4. Size three-way mixing or diverting valves not directly associated with pump subcircuit for 3-5 psi pressure drop.
5. Subcircuit is defined as all of branch supply and return piping to terminal device, including valve, coil, control valve, and balance valve.

1.3 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units and outside air bleed dampers for exhaust systems unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure setpoints. Use balance damper to provide additional pressure drop as required to obtain linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristics data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

A. General:

1. All modulating two-way hydronic control valves shall be pressure-independent modulating control valves.

2. If pressure independent control valves are not scheduled, manufacturer shall select valves meeting the requirements listed in Part D of this section and submit selection criteria for designer review.
3. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
4. Use 2 or 3 port normally open globe type control valves with equal percentage contoured throttling plugs for steam and water applications, except as otherwise noted.
5. Butterfly valves may be used for water system control valves 5" and larger provided that valves meet pressure and temperature requirements. High performance butterfly valves shall be used for modulating applications. General purpose butterfly valves may be used for 2 position control.

B. Globe Valves:

1. Manufacturers: Honeywell, Johnson Controls, TAC Americas, or Invesys Building Systems.
2. Valves shall be bronze or brass body, threaded ends for steel piping, solder ends for copper piping, 150 psi rating for 2" and smaller, iron body bronze mounted, flanged, 125 psi rating for 2-1/2" and larger.
3. Valves shall have stainless steel stems, spring-loaded teflon packing, replaceable stem/plug and packing kits.

C. General Purpose Butterfly Valves

1. Refer to Section 23 21 18 – Valves. Refer to Damper and Valve Actuators in this section for valve actuators.

D. Pressure-Independent Modulating Control Valves and BTU Meters (Air Handling Unit Coils):

1. Combination pressure independent control valve with integrated BTU Metering or pressure independent control valve with separate BTU Metering are acceptable.
2. Control Valves:
   a. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
   b. Modulating control valves shall be of "pressure independent" type configured with one integrated valve body that incorporates one chamber with an adjustable Cv and separate pressure regulating chamber used to maintain constant differential pressure across control surface.
   c. Control valve shall accurately control flow from 0 to 100% full rated flow with an equal percentage flow characteristic. Flow shall not vary more than +/- 5% due to system pressure fluctuations across valve with minimum of 5 PSID across valve.
   d. Combination of actuator and valve shall provide minimum close-off pressure rating of 200 PSI.
   e. A universal mounting plate shall allow installation of actuators meeting system electrical requirements and valve torque requirements.
   f. Actuators shall be mounted on valves at factory.
   g. Valves shall include visual verification of set flowrate and capability of adjusting flow in field by use of mechanical interface.
   h. Multi-turn actuators are NOT acceptable. Running time shall be 100 seconds independent of flow setting while rotating maximum of 90 degrees.
   i. Manufacturer shall warranty components for period of 5 years from date of production, with first two years unconditional.
3. BTU Meters
   a. BTU meter shall provide the following points as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be coordinated with the Temperature Controls Contractor.
   b. Temperature sensors and flow meter shall be part of the BTU Meter package.
   c. Temperature sensors shall be loop-powered current based (mA). The calculated differential temperature used in the energy calculation shall be accurate to within ±0.18°F.

d. Flow meter shall be electromagnetic type.

E. Pressure-Independent Modulating Control Valves (All 2-way hydronic coils other than AHU coils)

1. Manufacturers: Honeywell, Siemens, Belimo, Flow Control, Griswold, Johnson Controls, Danfoss, Bray
2. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
3. Modulating control valves shall be of "pressure independent" type configured with one integrated valve body that incorporates one chamber with an adjustable Cv and separate pressure regulating chamber used to maintain constant differential pressure across control surface.
4. Control valve shall accurately control flow from 0 to 100% full rated flow with an equal percentage flow characteristic. Flow shall not vary more than +/- 5% due to system pressure fluctuations across valve with minimum of 5 PSID across valve.
5. Combination of actuator and valve shall provide minimum close-off pressure rating of 200 PSI.
6. A universal mounting plate shall allow installation of actuators meeting system electrical requirements and valve torque requirements.
7. Actuators shall be mounted on valves at factory.
8. Valves shall include visual verification of set flowrate and capability of adjusting flow in field by use of mechanical interface.
9. Multi-turn actuators are NOT acceptable. Running time shall be 100 seconds independent of flow setting while rotating maximum of 90 degrees.
10. Manufacturer shall warranty components for period of 5 years from date of production, with first two years unconditional.

F. High Performance Butterfly Valves (Industrial Grade – Building CHW Isolation Valves):

1. Manufacturers: DeZurik, Xomox, Jamesbury, Posi-Seal, Bray/McCannalok or Fisher.
2. Carbon steel body, lugged style, ANSI Class 150, adjustable PTFE packing, PTFE seat with suitable metal back-up ring, upper and lower shaft thrust bearings, 316 stainless steel one-piece shaft and 316 stainless steel disc with offset shaft/disc design.
3. Normal and dead end (without downstream flanging) pressure rating shall be 275 psi.
4. Provide pneumatic actuator and positioner. Provide limit switches as required.
5. Valves and actuators shall be manufactured by, valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by, valve manufacturer.

G. Solenoid Valves:

1. Manufacturers: Asco, TAC, Inversys Building Systems, Honeywell, Johnson Controls, Landis and Staefa, Moore Industries, Robertshaw, or Schrader Bellows.
2. Brass or bronze body. Valves shall be selected to match required temperatures and pressure, and shall have materials, which are compatible with intended working fluid.
3. Line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.

2.2 CONTROL DAMPERS

A. General:

1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and 2 position (open/close) dampers shall be parallel blade type.
3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.

B. Standard Modulating and Two Position Dampers:

1. Manufacturers: TAMCO Series 9000 SW, Ruskin TED50XT, Johnson Controls VD-1251

   a. Preferred brand alternate: TAMCO Series 9000 SW

2. Damper frames shall be minimum 12-gauge extruded aluminum. Blades shall be minimum 12-gauge aluminum. Blades shall have maximum blade width of 6 inches with aluminum and steel trunnions mounted with polymer bearings. Blades shall be internally insulated and thermally broken.
3. Furnish dampers with blade seal and side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40 to 200°F, pressure differential of 6" WG, and approach velocity of 4000 fpm.
4. Dampers, when closed, shall be guaranteed by manufacturer not to leak air in excess of 8 cfm per sq ft at 4" WG static pressure based on 48”x48” size.
5. Dampers shall include salt water resistant construction with the following features:

   a. Clear anodized finish on aluminum frame and blades to a minimum depth of 0.7 mil.
   b. Silicone blade and frame seals.
   c. Stainless steel hardware, linkage parts, and screws in lieu of zinc-plated steel components.
   d. Aluminum linkage hardware with clear anodized finish.

2.3 SMOKE / ISOLATION DAMPERS

A. Acceptable Manufacturers: Air Balance, Johnson Controls, Ruskin, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff, Louvers and Dampers or Prefco, similar to Ruskin SD-60.

B. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 8” WG in closed position and to 4000 fpm in open position.

C. Actuator assemblies shall be installed outside the airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.

D. Dampers shall fully open in 15 seconds or less and fully close in not more than 15 seconds and not less than 5 seconds when activated.

E. Electric actuators shall be 120 volt non-stall type unless otherwise stated, and shall be rated for energized hold open position period of 12 months or more.

F. Provide position indicator switches to interface with building fire alarm system and Building Automation System.

G. Smoke detector required at each damper will be provided by Division 28 Contractor.

2.4 DAMPER AND VALVE ACTUATORS

A. Speed Control Valve:

1. Manufactures: ASCO, Parker Hannifin or approved alternate.
2. Provide speed control valves for On/Off actuators to limit speed of actuation to prevent water hammers in liquid systems and reduce stresses on large dampers in air systems.
3. Speed control valves shall allow free flow of control air in one direction and metered flow in other direction. Valve stem locks shall be included to lock adjustment knob in place.

4. Mount speed control valve to exhaust port of solenoid control valve or impulse line from solenoid control valve to actuator, depending upon whether speed control is required for closing or opening of valve of damper.
5. Materials of Construction: Brass bodies with Buna-N, NBR or Nitrile Seals.

B. Analog Electronic:

1. This actuator to be used for terminal heating/cooling control valves and dampers only.
2. Manufacturers: Belimo, Honeywell, Johnson Controls, Landis and Staefa, TAC Americas, or Siebe Environmental Controls (Robertshaw/Barber-Colman).
3. Actuators shall be hydraulic or electric motor/gear drives which respond proportionally to analog voltage or current input. Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with its associated local controller, but no more than 6 minutes.
4. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.
5. Floating point control for electric actuators is not acceptable.

C. Discrete Two – Position Electric:

1. Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies, TAC or Invensys Building Systems.
2. Actuators shall by hydraulic or electric motor/gear drives for two position control. Stroke time shall be 90 seconds or less for 90˚ rotation.
3. Provide spring return for fail open or closed positions.

D. Discrete Two-Position Heavy-Duty Electric:

1. Manufacturers: Valvcon, Rotork, Limitorque or Automax.
2. Actuators shall be hydraulic or electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.
3. Provide spring return feature for fail open or closed positions as required by control sequence.
4. Unless otherwise indicated, actuator power shall be 120 VAC, 60 Hz, single phase.

PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequence specified.

B. Control valves, furnished by Control Contractor will be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valves will be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers as shown on drawings and/or as required to perform control sequence specified except those furnished with other equipment.

B. Control dampers furnished by Control Contractor will be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers will be provided by Mechanical Contractor.

D. Control dampers used for outside, relief, or exhaust air shall be installed a minimum of 6” away from wall penetrations to allow for external mounting of actuators. Locate all dampers actuators outside airstream with positioning relays as required.

3.3 SMOKE/ISOLATION DAMPERS

A. Furnish smoke/isolation dampers as shown on drawings.

B. Smoke dampers furnished by Control Contractor will be installed by Mechanical Contractor.

3.4 ACTUATORS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut off against maximum system temperatures and pressure encountered. Each actuator shall be full-proportioning or two-position type as required or specified and shall be provided with spring-return for fail open or fail closed position for fire, freeze, occupant safety, equipment protection, moisture, heating or cooling protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail closed.

B. Valve and damper operating speeds shall be selected or adjusted so operators will remain in step with controller without hunting regardless of load variations. Operators acting in sequence with other operators shall have adjustment of control sequence as required by operating characteristics of system.

C. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve steam/damper shaft/ideal movement) due to deflection of actuator mounting.

D. Calibrate position feedback potentiometers where specified with range and gain factors as required for proper operation per manufacturer's recommendations.

E. Provide speed control valves for on/off actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

END OF SECTION 230902

SECTION 230903 - CONTROLS INSTRUMENTATION

PART 1 - GENERAL

1.1 FCC COMPLIANCE

A. Digital equipment furnished under this contract shall have been tested and made to comply with the limits for a Class A computing devices pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environment. Literature shall so note and all equipment shall be so labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pressure and temperature ratings of devices indicated in Part 2 - Products are minimum required. All devices shall be designed to withstand maximum pressure and temperature encountered in the respective system.

B. Devices containing mercury shall not be allowed under this specification.

2.2 GENERAL INSTRUMENTATION

A. Pressure gauges shall be provided by Division 23 Contractor.

B. Thermometers shall be provided by Division 23 Contractor.

C. Analog Electronic Instrument Indicators:

1. Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2” square. Output may be analog needle type or digital with ½” high LED or backlit LCD displays.
2. Electronic indicators shall be marked in appropriate units (Degrees, PSI, %RH, GPM, CFM, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

2.3 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

1. Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of the project. Terminal connections shall be made at terminal blocks inside of NEMA 12 enclosures unless otherwise specified. Outdoor units shall be NEMA 4 with concealed adjustment.
2. Ratings of normally open and closed contacts shall be adequate for applied load (Minimum 5 amps at 240 volts).
3. Accuracy of devices shall be ± 1% of scale with adjustable offset unless otherwise specified.

B. Relays:

1. Manufacturers: IDEC, Potter Brumfield, Square D, or Allen Bradley.
2. Equal to IDEC type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 15A, 30 VDC, or 120 VAC. Coil shall match control circuit characteristics. DDC outputs shall be 24 VDC with maximum current burden of 50 milliamps. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.
3. Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.

C. Enclosed Relay (Relay-in-a-box):

1. Manufacturers: Veris Industries, Kele & Associates, Functional Devices, Inc. or approved equal.
2. 1 or 2 SPDT relays in NEMA 1 or better enclosure. Coil shall be selected for control circuit characteristics.
3. Contacts rated at 10A, 29 VDC or 120 VAC. Conduit nipple is ½" NPT. Maximum coil current burden of 50 milliamps.

D. Temperature Switches (Electric Thermostats):

1. Line voltage or low voltage type suitable for application with adjustable setpoint and setpoint indication.
2. Low voltage type to have heat anticipation.
3. Wall mounted space thermostat enclosure shall have concealed sensing element and exposed setpoint adjustment.

E. Temperature Low Limit Switches (Freezestats):

1. Electric 2 position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any one foot length of sensing element is subject to temperature below setting.
2. Sensing element shall not be less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, calibrate temperature switch setpoint to 38°F.
3. Provide adjustable time delay relay for 0.5 to 5 minutes. Time delay relay shall be wired between freezestats and controller to allow air handling unit mixed air to stabilize upon startup or transition from unoccupied to occupied mode to prevent spurious trips from occurring when outside air damper(s) opens and cold outside air enters air handling unit.

F. Pressure Differential Switches:

1. Manufacturers: Allen Bradley, Cleveland Controls, Ashcroft, Barber-Colman, Dwyer, Honeywell, Johnson Controls/Penn, Invensys, SOR, or United Electric.
2. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.
3. Pressure differential switches for air systems shall have pressure rating of at least 10" wg.
4. Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.
5. Pressure differential switches for water systems shall be rated for 150 psig unless otherwise noted. Chilled water pressure differential switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches to have 3-valve manifold for servicing.

   a. Maximum Temperature Rating: 180°F
   b. Repeatability: ± 1%

G. Position Switches (End Switches):

1. Manufacturers: Allen Bradley, GE, Johnson Controls/Penn, Honeywell, Square-D, Westinghouse, or Westlock.

2. Provide valve position switches, toggle switches, and wall switches as required to meet specified sequence. Rotary switches shall be cam action, lever, or proximity type.
3. Switches containing mercury shall not be used.

H. Current Switches – Constant Load, Constant Speed:

1. Manufacturers: Veris Industries, N-K Technologies, Absolute Process Instruments, Kele & Associates, R-K Electronics or approved equal.
2. These shall be induction type sensors clamped over single phase conductor of AC electrical power and shall be solid-state sensors with adjustable threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.

a.	Output:	Solid state relay or relay contacts
b.	Trip Setpoint:	Adjustable by multi-turn potentiometer
c.	Operating Temperature:	0 to 55°C (32 to 131°F)
d.	Response Time:	<0.5 seconds

I. Current Switches – Variable Load, Variable Speed:

1. Manufacturers: Veris Industries, N-K Technologies or approved equal
2. These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall consist of solid-state sensors with self –calibrating threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.

a.	Output:	Solid state relay or relay contacts
b.	Trip Setpoint:	Self-calibrating through microprocessor
c.	Operating Temperature:	0 to 55°C (32 to 131°F)
d.	Response Time:	<0.5 seconds

J. Mechanical Room and Local Control Panel Alarm Horns:

1. Manufacturers: Honeywell, Panalarm, Johnson Controls, Invensys or Federal Signal.
2. 24 volt alarm horn suitable for panel mounting.

K. Indicator Lights:

1. Manufacturers: Allen Bradley, GE, Square-D, or Westinghouse.
2. 1/4" minimum size, push-to-test type. Use green for normal, yellow for warning (low/high values), and red for alarm or fail (low-low or high-high conditions). AC or DC type with voltage matched to control circuit without transformers.

L. Moisture Detector:

1. Moisture detector is small, electronic control relay for detecting rising water levels in containment areas and drain pans.
2. Relay is normally energized upon powering up and no water is present. When water level reaches the trip point the relay de-energizes for alarming in BAS.
3. Moisture detector shall alarm as follows:

a.	Containment areas:	Whenever water is detected.
b.	Drain pains:	Whenever water levels reach 0.43” to prevent damage from overflow of drain pans. Relay shall reset when water levels decrease to 0.31” and relay re-energizes.

4. Moisture Detector Relay Module:

   a. Supply Voltage: 24 VAC, 60 Hz
   b. Power Consumption: 1 W
   c. Cable length: 18”
   d. Relay Contacts:

      1) Type: SPDT
      2) Rating: 2.5A at 24 VDC; 5.0A at 120 VAC

   e. Enclosure Rating: Hermetically Sealed

M. Cable Float Type Level Switches:

1. Manufacturers: SJE-Rhombus, See Water, Hydromatic Zoeller, Dwyer, Flowline, Madison, or approved equal
2. Mechanically actuated floating switch intended to activate electrical components to start and stop automatically.

   a. Wetted Materials: Housing – polypropylene
      Cable – PVC
   b. Process Temp Limits: 32°F to 120°F
   c. Enclosure Rating: IP68
   d. Input/Output: As required for controlled equipment
   e. Cable Length: As required for mounting and control requirements

3. Provide counterweight for stabilizing and calibrating cable location within tank.

N. Side-Mount Float Type Level Switches:

1. Manufacturers: Dwyer, Madison, Solutions With Innovation, or approved equal
2. Hermetically sealed reed switch actuated by magnet permanently bonded inside float arm designed to be mounted through walls of liquid holding tanks.

   a. Wetted Materials: Polypropylene
   b. Temperature Limit: 32°F to 170°F

2.4 PNEUMATIC INSTRUMENTATION

A. Differential Air Pressure Indicator:

1. Dwyer model 2000 Series magnehelic gauge for surface or panel mounting or approved equal. 4" dial readout, die cast aluminum housing. Case and aluminum parts Iridite-dipped. Exterior finish to be baked dark grey hammerloid. Hi/lo 1/8" pressure taps. Provide adapters to match tubing type:

   a. Accuracy: ± 2% of full scale
   b. Ambient Temp Range: 20 to 140°F
   c. Rated Total Pressure: -20" Hg to 15 PSIG
   d. Fan Room Range: 0.125 to -0.125" WC
   e. Filter Range: 0 to -4" WC

B. Outdoor Static Pressure Sensor:

1. Manufacturer: BAPI ZPS-ACC10, Dwyer A-306, Air Monitor Corporation SOAP, Vaisala SPH20, or approved equal.
2. Sensor shall effectively reduce the fluctuation of outdoor static pressures as caused by wind gusts.
3. Constructed of aluminum, stainless steel, and/or UV resistant plastic suitable for exterior installation.
4. Provide low differential pressure transmitter.

C. Space Static Pressure Sensor:

1. Manufacturers: BAPI, Dwyer, Air Monitor Corporation, Tek-Air, or approved equal
2. Space static pressure probe shall be brushed aluminum with anodized finish or stainless steel with polished or painted finish selected by Architect.
3. Static air probe shall be similar to BAPI ZPS for wall mounting, complete with 100 micron filter, foam gasket, and barbed fitting for tubing connection.

D. Plastic Tubing:

1. Fire resistant virgin polyethylene, meeting stress-crack test ASTM D1693. Individual tube polyethylene or multi-tube instrument tubing bundle shall be classified as flame retardant under UL 94. Polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D635.

2.5 ANALOG ELECTRONIC INSTRUMENTATION

A. Space Temperature Sensors:

1. Sensors shall be 20,000-ohm thermistor type, with the following minimum performance:

   a. Accuracy: ±0.5°F
   b. Operating Range: -40 to 140°F, 0 to 99% rh

2. Unless otherwise stated, space sensor cover shall be manufacturer's standard plastic cover.
3. Provide space temperature sensors based on locations as follows unless otherwise specified:

   a. Public spaces, corridors, mechanical rooms: Temperature sensors without remote setpoint adjustment, without override, and without display.
   b. Offices, classrooms, spaces occupied by regular staff (e.g. Makerspace, Greenscreen, Digilab, Scanning): Temperature sensors with space temperature indication to the digital controller, software-limited occupant setpoint adjustment (warmer-cooler slider bar or switch), and limited operation override capability.
   c. Special collections archive: Temperature sensors with display, without remote setpoint adjustment, without override.
   d. Entry vestibules with ceiling mounted sensors: Temperature sensors without remote setpoint adjustment, without override, and without display, designed for recessed installation in ceiling.

B. Space CO2 Sensors

1. Provide Carbon Dioxide Monitor as listed below. The system shall be a complete package with integral sensor, monitor, alarm contacts.

   a. Gas to be Detected: Carbon Dioxide (CO2)
   b. Sensor: Non-dispersive infrared technology
   c. Range: 0 to 2000 ppm
   d. Accuracy: ± 75 ppm at 600 ppm and 1,000 ppm at sea level and 25°C
   e. Response Time: Less than 60 seconds
   f. Power Requirements: 20-30 VAC or VDC
   g. Signal Input: Integral Sensor
   h. Signal Output: 0-10 VDC
   i. Mounting: Wall-mounted

2. Data shall be recorded on system with DDC to the zone level.
3. Unit shall have adjustable set points and self-test diagnostics.
4. Certified by manufacturer to require calibration no more frequently than once every 5 years.
5. Unless otherwise stated, space sensor cover shall be manufacturer's standard plastic cover.

C. Duct Mounted and Outside Air Temperature Sensors:

1. Sensors shall be 20,000-ohm thermistor type, with the following minimum performance:

   a. Accuracy: ±0.5°F
   b. Operating Range: -40 to 160°F, 0 to 99% RH

2. Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in outside air intake plenum serving air handling units to avoid thermal effects from direct sunlight.
3. Duct-mounted insertion measuring probe length shall be appropriate for duct size and include utility box and gasket to prevent air leakage and vibration noise.
4. Sensors mounted in air streams, such as air handling units, supply ducts, exhaust ducts or return ducts, shall be averaging type. Averaging type sensor to be installed in ducts larger than 24" x 24" or greater than 576 in^2. Mount averaging sensor across duct area in a "Z" pattern using mounting clips specific for averaging temperature sensor probes.

D. Direct Insertion Temperature Sensors:

1. Sensors shall be 20,000-ohm thermistor type, with the following minimum performance:

   a. Accuracy: ±1%
   b. Operating Range: -5 to 250°F

      1) Limited range sensors shall be acceptable provided they are capable of sensing the expected range for the point at the specified accuracy.

2. Sensor assembly shall be direct insertion, suitable for use with water systems, 150 pound class, minimum rating.
3. Provide thermal well with heat conductive gel.

E. Humidity Sensors/Transmitters:

1. Thin-film capacitive type sensor with on-board nonvolatile memory. Sensor/transmitter shall have the following minimum performance:

   a. Accuracy: ±2% at 0 to 90% RH
   b. Repeatability: 0.1% RH
   c. Hysteresis: Less than 1%
   d. Long Term Stability: Less than 0.25% RH per year
   e. Operating Range: 0 to 100% RH, non-condensing
      32 to 140°F
   f. Output: 4-20 mA, or 0-10 VDC, 0-100% linear, proportional
   g. Power: 12-30 VDC

2. Unless otherwise stated, space sensor cover shall be manufacturer's standard plastic cover.
3. Duct-mounted insertion measuring probe length shall be appropriate for duct size and include utility box and gasket to prevent air leakage and vibration noise.
4. Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in outside air intake plenum serving air handling units to avoid thermal effects from direct sunlight.

F. Wet/Wet Differential Pressure Transmitter:

1. Manufacturers: Veris Industries, Setra, Honeywell, or Schneider.
2. Pressure sensor and integral 4-20 mA VDC transmitter. Select instrument for intended usage (differential pressure, gauge pressure, level, etc.), range, maximum pressure/temperature. Enclosure to be NEMA 4 with LCD display.

3. Differential pressure transmitters shall have the following characteristics:

   a. Construction: Stainless steel for all wetted components
   b. Process Connection: 1/4" NPT Stainless Steel
   c. Power Supply Voltage: 12 to 30 VDC
   d. Burst Pressure: 250 psig
   e. Process Temperature: 30°F to 185°F
   f. Ambient Temperature: 14°F to 130°F
   g. Performance:

      1) Zero: Pushbutton auto-zero and digital input terminal.
      2) Accuracy: ± 1% of calibrated span.
      3) Drift: ± 0.25% per year.
      4) Temperature Effect: ± 1.5% upper range limit.

   h. Provide remote sensing element(s) whenever operating temperature exceeds transmitter maximum temperature.

4. Provide multi-valve manifold assembly for each hydronic pressure differential transmitter. Manifold assembly shall include the following:

   a. Two isolation valves
   b. One or two vent valve(s)
   c. One equalizing valve

G. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:

1. Manufacturers: GE Modus, Setra, Ashcroft XLDP or approved equal.
2. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
3. Unit shall be capable of transmitting linear 4 to 20 mA DC output signal proportional to the differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:

   a. Span: Not greater than twice the duct static or velocity pressure at maximum flow rate, nor more than 16 times velocity pressure at minimum flow rate.
   b. Accuracy: ± 1.0% of span or ± 1.0% of full scale
   c. Dead Band: Less than 0.5% of output
   d. Hysteresis: Within 0.5% of span or within 0.5% of full scale
   e. Linearity: Within 1.0% of span or within 0.5% of full scale
   f. Repeatability: Within 0.5% of output
   g. Response: Less than 1 second for full span input

4. Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from the static pressure sensing stations, and static air probes to prevent migration of moisture or particulate matter into transducers. Supply air system sensors do not require integral air filters.

H. Low Differential Pressure Transmitter (Building and Space Differential Pressure):

1. Manufacturers: Dwyer Series 677B, Setra Model 264, Paragon DPT-4001, Ashcroft CXLdp, or approved equal
2. Bi-directional, low differential pressure transducer with the following characteristics:

   a. Pressure Range: -0.1"psi to 0.1"psi
   b. Accuracy: ±0.4% calibrated range
   c. Stability: ±1% calibrated range per year
   d. Operating Temp Range: 0°F to 160°F
   e. Input: 12-30 VDC

f. Output Signal: 4-20 mA

I. Thermal Dispersion Air Flow Measurement Sensor/Transmitter:

1. Manufacturers: Ebtron or approved equal.
2. Duct Mounted Flow Sensor:

a. Multi-probe type thermal dispersion flow sensing station consisting of aluminum probe assembly with flanged connection and multiple hermetically sealed sensors in glass-filled polypropylene housing. Arrangement of sensors along probe assembly factory set to perform equal area traverse of duct cross section.

b. Flow Sensor:

1) Accuracy: ± 2% of reading
2) Repeatability: ± 0.25% of reading
3) Materials: Probe – Aluminum
Sensor Housing – Glass-Filled Polypropylene
Mounting Brackets – 304 SS
4) Calibrated Range: 0-5,000 FPM

c. Temperature Sensor:

1) Accuracy: ± 0.15%
2) Sensor Temp. Range: -20°F to 160°F (0-1,500 FPM)
30°F to 160°F (>1,500 FPM)
3) Humidity Range: 0-99%, non-condensing
4) Probe Size Range: 8” to 120”

d. Transmitter:

1) Power Requirements: 24 VAC (2 to 29 VAC), 8 VA max.
2) Enclosure: Aluminum Housing
3) Outputs: 4 to 20 mADC
4) Output Resolution: 0.025% of selected range

a) Output 1: Airflow (0 to 5,000 FPM)
b) Output 2: Temperature (-20°F to 160°F)

5) Ambient Temperature: -20°F to 120°F

e. LCD Display

J. Fan Array Airflow Totalizing Transducer System:

1. System shall connect to piezometer rings installed on individual fans within a fan array to determine the airflow of each individual fan based on the differential pressure and fan manufacturer-provided flow coefficient. Airflow measurement for each fan and totalized airflow of the entire array shall be reported to both the BAS and a local display for control and monitoring purposes.
2. Airflow calculations shall be based on fan manufacturer’s specified flow coefficient, project elevation, and air temperature, with accuracy of ± 0.25% of full scale for each fan in the array.
3. Analog outputs to the BAS shall be field selectable for 4-20mA, 0-5 VDC, or 0-10 VDC.
4. System shall provide network communication to the BAS for monitoring and control purposes via BACnet or Modbus communication network. The network information shall provide individual fan information and remote configuration of programmable values.
5. Local display interface shall display individual fan airflow and status, and totalized airflow rates for each fan array. Interface shall provide individual fan diagnostics for measured differential pressure and transducer output. Interface shall permit automatic zero and span calibration of each individual pressure transducer.

6. System shall provide individual fan failure alarming capability to both the BAS and local display panels. Alarms shall be generated when:
   a. Airflow rate for individual fan is above or below the average for all fans in the array by a programmable percentage value.
   b. Airflow rate for an individual fan goes to zero.
7. Single transducer system may be used for supply and return fan array on a single AHU, provided all characteristics described above are available for each array.

K. Insertion Electromagnetic Flowmeters:

1. Manufacturers: Onicon F-3500, Badger Meter, Armstrong, or approved equal
   a. Preferred Brand Alternate: Onicon F-3500
2. Insertion electromagnetic flowmeter with NIST traceable wet calibrated flow-measuring element.
3. Flowmeter shall have the following characteristics:

a.	Construction:	316L stainless steel for all wetted components NEMA 4 enclosure
b.	Accuracy:	± 1% of flow rate from 2.0 to 20.0 ft/s (10:1 turndown) ± 0.02 ft/s below 2.0 ft/s
c.	Flow Range:	0.1 ft/s to 20 ft/s (200:1 turndown)
d.	Maximum Pressure:	400 psig
e.	Process Temperature:	15°F to 250°F
f.	Ambient Tempreature:	-20°F to 150°F
g.	Input:	20-28 VDC or 20-28 VAC
h.	Outputs:	
1)	Analog:	Selectable: 4-20 mA, 0-1 V, or 0-5 V
2)	Frequency:	0-15V peak pulse, 0-500 Hz
3)	Scalable Pulse:	50 VDC, 100 mA maximum; 0.5, 1, 2, or 6 second duration

4. Meter shall be wet tappable complete with installation valves and installation depth gauge.
5. Integral transmitter capable of interfacing with Energy Meter (where specified) and LonWorks, BACnet, or MODBUS protocol.
6. Provide local display for instantaneous and totalized flow information.
7. Provide grounding rings or probes for installations on non-metallic piping.

L. Energy (BTU) Measurement System:

1. Manufacturers: Onicon, Badger Meter, Armstrong, or approved equal
   a. Preferred Brand Alternate: Onicon System-10 BTU Meter with F-3500 Insertion Electromagnetic Flowmeter
2. Entire system shall be built and calibrated by a single manufacturer and consist of BTU meter, flowmeter, two temperature sensors, temperature thermowells, and all required mechanical installation hardware.
3. Energy Meter:
   a. Capable of interfacing with BAS via LonWorks, BACnet, or MODBUS protocol.
   b. NEMA 4 enclosure with integral LCD display.
   c. Factory programmed for specific application.
   d. Output points to both BAS and LCD screen shall include:
      1) Energy Total
      2) Energy Rate
      3) Flow Rate
      4) Supply Temperature

5) Return Temperature

4. Flowmeter:

a. Insertion electromagnetic type.

5. Temperature Sensors:

a. Matched pair of current based sensors appropriate for application temperature range.

M. Ultrasonic Level Transmitters:

1. Manufacturers: Dwyer, Flowline, Madison, or approved equal.
2. Ultrasonic level sensor and transmitter for non-contact, continuous fluid level measurement with programmable relays for switch, pump, or valve control.

a.	Service Compatibility:	Water
b.	Sensing Rage:	Full depth of installed tank
c.	Accuracy:	± 0.25% of full range
d.	Input:	12-30 VDC
e.	Output:	4-20 mA

Provide accessories as required for proper installation and calibration (e.g. USB connector, tank mounting bracket).

N. Current Transformers:

1. Manufacturers: General Electric, Square D, Veris Industries, or Kele.
2. Alternating current transformers shall conform to the latest applicable standards including AEIC, EEI-NEMA, Standards for Instrument Transformers (MSJ-11) and ANSI Standard C57.13 for instrument transformers.

a.	Rated Voltage:	480 Volts
b.	Insulation Class:	600 Volts
c.	Basic Impulse Level:	60 Hz
d.	Short Time Current Rating:	100% (1 second)
e.	Accuracy Class:	0.3
f.	Continuous Current Rating:	150% Pressure (E-P) Transducers:

O. Compound Water Meter (Domestic Water Meter)

1. Water meter shall be provided by controls contractor and installed by plumbing contractor.
2. Acceptable Manufacturers: Neptune, Badger, Sensus, Metering Systems or approved equal.

a. Preferred Brand alternate Neptune meter with E-coder Register.

3. Meter shall be in-line compound meter type consisting of one positive displacement chamber and one turbine chamber. Meter shall have integral or remote converter with graphic display and keypad. Meter shall be factory sized and programmed for its specific application and flow range. Meter shall be reprogrammable using converter keypad without use of special interface device or computer.
4. Meter body shall be lead-free bronze construction with stainless steel trim. Meter shall have thermoplastic piston, turbine chamber and turbine. Meter materials and finish shall meet AWWA Standard C700
5. Meter shall be provided with ANSI CLASS 150 flanges.
6. Coordinate with BAS to automatically capture totalized volume and instantaneous flowrate.
7. Meter shall have integral lead-free bronze or stainless-steel plate type strainer. Strainer shall have access cover for cleaning of strainer grid.
8. Meter shall provide instantaneous and totalized flow in GPM and GAL.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment, wiring and air piping in neat and workmanlike manner to satisfaction of Architect and/or Engineer, and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc. required for proper operation of each device. Mark and detail exact location of inline devices, wells, and taps to be installed by Mechanical Contractor on coordination drawings.

B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished by Control Contractor which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. Mount motor control devices within 5 ft of disconnect switch, or starting device furnished by Electrical Contractor unless noted otherwise. Maintain required NEC clearances.

E. Control Contractor and Mechanical Contractor shall review proposed static pressure sensor and flow meter locations with Owner and Engineer for approval prior to installation.

3.2 GENERAL INSTRUMENTATION

A. Pressure Gauges (Pressure Indicators):

1. Install pressure gauge for indication of supply and control pressure in pneumatic systems at output of controllers, I/P transducers, electric air solenoid valves, es and other points where visible indication of air pressure is required for operating and maintenance purposes.
2. Provide test port for quick connection of test gauges at valve, damper motor and other actuator branch lines.
3. Pressure gauge tappings in piping will be provided by Mechanical Contractor.

B. Thermometers (Temperature Indicators):

1. Install thermometers at each point of temperature transmission and control, except for those that are indicated at local control panels. Install thermometers to permit easy reading from floor or operating platform (within 3 ft of line of sight). Provide remote bulb thermometers with readout indicators mounted within 3 ft of line of sight whenever sensing point is more than 3 ft from line of sight.
2. Thermometer wells in piping will be installed by Mechanical Contractor.

C. Local Control Panels:

1. Install remote mounted devices, controllers, I/O terminal blocks, power supplies, etc. inside of local control panels.
2. Locate panels as shown on drawings.
3. Locate panels adjacent to equipment served with minimum of 3 ft clearance in front of door. Provide sufficient clearances to allow full door swing and full access to internal components. Submit proposed panel locations with shop drawings.
4. Mount top of panel between 5 and 6 ft above floor so that gauges and indicators are at eye level.

D. General Instrumentation at Local Control Panels:

1. Provide record control drawings of systems served by each local panel, in location adjacent to or inside of panel cover. Provide protective cover for drawing.

3.3 DISCRETE AND ANALOG INSTRUMENTATION

A. Wall Mounted Space Thermostats/Temperature Sensors:

1. Install space thermostats/sensors where indicated, as required to perform specified control sequences, and as directed to meet job site conditions.
2. Mount space thermostats/sensors as indicated on architectural elevations or 4 ft above floor unless otherwise noted.
3. Space thermostats/sensors located on exterior walls shall be mounted on thermally insulated sub-base.
4. Relocate space thermostats/sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.

B. Low Limit Temperature Switches (Freezestats):

1. Install low limit controls where indicated on drawings or as specified. Unless otherwise indicated, install sensing element at upstream side of cooling coils.
2. Distribute sensing element across entire area of medium being sensed. Install controls at accessible location on outside of air handling unit no higher than 6’-0” above finished floor with suitable mounting brackets and element duct collars where required.

C. Static Pressure and Air Flow Stations:

1. Furnish static pressure and air flow measuring stations to mechanical contractor for installation.
2. Stations shall be installed in strict accordance with manufacturer’s published requirements. These stations serve as primary signals for airflow control systems, therefore, it shall be responsibility of Control Contractor to verify location and installation to assure that accurate airflow signals are obtained.

D. Direct Insertion Temperature Sensors:

1. Install sensor so that sensor is pointed downstream.

E. Water Flow Meters and Flow Switches:

1. Install flow measuring devices with recommended straight pipe diameters upstream and downstream of elbows, tees, valves, or other fittings which cause uneven turbulent flow conditions.
2. If no recommendations are given, provide straight pipe equal to 10 pipe diameters upstream and 5 pipe diameters downstream.

F. Sensor Wells:

1. Mount sensor wells as shown on drawings and other gravity return as required by other contract documents. Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided element is always in the flow, (for condensate and other gravity return lines, install in bottom of pipe). Wells mounted in pipe 2-1/2" and smaller shall be installed at elbow tee fittings with well pointed upstream. Minimum of 2" pipe size for elbow tee installation.

G. Transmitters and Indicators:

1. Locate transmitters at sensing device or within 100 ft for remote mounted transmitters. For hot systems (150°F and higher) mount electronics on side of pipe or remotely mount. For indicating type instruments, locate indicating element with 6 ft of the floor with readout easily visible from floor level. Provide remote readouts if necessary.
2. Provide pressure transducers integral to DDC panels or separate components to convert digital analog signals to variable pneumatic air signals.
3. Provide P-E transducers to convert analog pressure signals to analog electronic signals for input to DDC panels.

H. Thermal Dispersion Airflow Meters:

1. Control Contractor shall furnish air flow meters to Mechanical Contractor for duct mounting. Where airflow meters are shown to be installed in air handling units, Control Contractor shall send meters to air handling unit manufacturer for factory mounting.
2. Provide all hardware required for mounting of units in ductwork and/or air handling units. Mechanical Contractor to provide access door upstream of meter for servicing as specified in Section 233314 – Ductwork Specialties.
3. Airflow Meter Manufacturer shall provide qualified representative to supervise installation of airflow meters to assure proper spacing for proper measurements per manufacturer's installation instructions.

END OF SECTION 230903

SECTION 230993 - CONTROL SEQUENCES

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. This section describes the manner and methods by which the control systems shall function.

B. The contracgtor will alos provide the LTACS and manage manage the overall integration.

1.2 SUBMITTALS

A. Refer to Section 230901 – Building Automation Systems and Division 01 for requirements for control system shop drawings, product data, software user manual, O&M Manuals, etc.

B. Programming Manual

1. Provide DDC system programming manual as well as documentation of site specific programming and completion checklists prior to start of functional testing of systems to be commissioned.

1.3 PROJECT RECORD DOCUMENTS

A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual control and alarm setpoints and tuning parameters as existed at time of Owner acceptance of systems.

B. Record documents shall be modified control drawings (M7 Series Drawings) and other documents as specified in Section 230901 – Building Automation Systems with actual installed information. Provide all supporting files, blocks, fonts, etc. required by the drawings.

C. Provide final points list for work specified herein including programmed alarm setpoints.

D. Provide final detailed wiring diagrams with all wiring numbers and termination points indicated.

E. Provide updated final control sequences and software logic diagrams for installed systems including all changes made after submission of shop drawings.

F. Provide actual installed location of control devices (i.e., temperature, humidity, and differential pressure sensors, etc.) to Mechanical Contractor for inclusion in ductwork and piping as-built drawings prepared by Mechanical Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Not Applicable.

PART 3 - EXECUTION

3.1 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 control devices and programming necessary to obtain the sequences/system operation indicated and shall submit all setpoints, control parameters, and alarm setpoints The Control Contractor shall also incorporate standard features such as minimum runtime delays and deadbands from setpoints to prevent short cycling and nuisance alarms. All monitored points shall include early warning alarm (high/low) notifications prior to taking corrective measures such as equipment shutdowns or fault alarms. Transmitters shall include out-of-range, fail safe positioning for open circuits or loss of communications. Control Contractor shall include as part of submitted controls specific instances where fail de-energizers, hold last state, or default to predetermined setpoint will be programmed. Control Contractor shall also provide additional hardware and programming for control points shown elsewhere in the Contract Documents which may not be directly related to any specified control sequence. These basic features that are necessary and are part of a robust controls installation are included in the scope of services for deliverables at no additional cost to Owner.

B. The following system components shall have monitoring and historical trending set up at time of project completion for energy management and troubleshooting. The existing user workstation shall provide storage of information and shall allow retrieval of information in tabular or graphic form.

1. Run hours and operating status of each major piece of equipment (chilled water pumps, hot water pumps, air handling units and exhaust fans).
2. Calculated building heating load (MBH) using flow data as well as heating hot water supply and return temperatures.
3. Calculated building chilled water load (tons) using flow data as well as chilled water supply and return temperatures.
4. All metering specified for power, natural gas and water use shall be transmitted from the meter's storage register to the BAS and shall be provided on a dedicated graphics page. Contractor shall ensure that each meter is installed per specifications and manufacturer installation instructions and that meter readings displayed at the BAS match the display on the face of the meter. Readings displayed on each meter are to be verified as correct during Test and Balance and commissioning work.

   a. Bid Alternate 16B: Metering for the Condensate Reclaim Water system shall be included in the above requirements.

C. All points that are monitored shall be configured for trending with the trend rate field adjustable.

D. Provide mapping and connection of all communication bus linked and hard-wired inputs/outputs to the BAS for points shown on flow and control diagrams (M7 series drawings) or in the specific equipment specifications.

E. The design intent is to provide a complete control system encompassing the requirements of the specifications and control diagrams. If requirements of the specifications and the control diagrams are in conflict, the Designer shall be consulted for clarification before purchasing equipment or programming the controls.

F. 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
Outside air damper	closed	closed
Exhaust/relief air damper	closed	closed
Return air mixing damper	open	open
Supply air isolation damper	closed	closed
Return air isolation damper	closed	closed
Var. Freq. Drive	Off	Min. Speed (see note below)

1. Variable Speed Drives: For a VSD dependent on an external input for its output setting (e.g. the VSD gets "frequency" as an input), loss of that external input shall result in the VSD holding its last value. If the VSD is running on its own PID loop and the external input to the VSD is a setpoint (e.g. duct static pressure setpoint), the VSD shall hold the last setpoint. If the VSD loses its process variable (e.g. duct static pressure), the VSD shall go to minimum speed setting.

G. 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 "proportional plus integral (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.

H. Wherever a value is indicated as adjustable (FA), it shall be modifiable, with the proper password level, from the operator interface 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 primary control unit (PCU) is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the PCU is powered by uninterruptable power supply (UPS), or if PCU is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable) for one of the PCUs. When the BAS detects that power has been restored, all equipment for which the BAS start command had been retracted shall be automatically restarted on staggered 5 second intervals to minimize inrush current. When loss of equipment status coincides with a power failure, system shall not alarm individual equipment failures. Instead, only a single alarm shall be enunciated as follows:

1. RANDALL LIBRARY EXPANSION POWER FAILURE: Notify electric shop. Acknowledge alarm when power is restored.

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. As an alternative 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 and via an alarm message at the operator interface and print at the alarm printers. A descriptive message shall be attached to the alarm message indicating the nature of the alarm and actions to be taken. Contractor shall provide messages to meet this intent. 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. Travel rate of control valves and dampers

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 prohibited. 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.

P. The initial supply duct static pressure setpoint range is given in this specification, but the final duct static pressure setpoint for systems shall be determined through coordination with the TAB Contractor as

follows: The Control Contractor shall adjust supply airflow to maximum flow for all terminal boxes and then gradually reduce the static pressure setpoint until at least one air terminal box is greater than 90% open (damper position) and all air terminal boxes are meeting airflow setpoints. This static pressure setpoint shall then become the maximum setpoint for the supply duct. The Control Contractor shall then adjust supply airflow to minimum flow for all terminal boxes and then gradually reduce the static pressure setpoint until at least one terminal box is greater than 90% open and all air terminal boxes are meeting their airflow setpoints. This static pressure shall become the minimum setpoint for the supply duct. Duct static pressure maximum and minimum values shall be determined within 0.05" WG based on the test criteria stated above.

Q. Supply air temperature sensors for terminal boxes or duct mounted reheat coils shall be located a minimum of 5 feet downstream of heating coils to provide proper temperature sensing.

R. Control Contractor shall be responsible for programming delays for alarming purposes when equipment is energized to prevent false alarm signals.

S. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 10 second (FA) intervals to minimize inrush current.

T. Alarm messages specified throughout the sequences are assigned to discrete priority levels as follows:

1. Level 1 alarm – critical alarm affecting life safety
2. Level 2 alarm – critical alarm protecting equipment functions
3. Level 3 alarm – non-critical maintenance alarm

U. All alarms as defined in the following control sequences or on the drawings or specifications shall be logged by an alarm manager. The manager shall include a description of the event, time, and date of occurrence. The alarm shall remain latched with a visual alarm (Level 3) and visual/audible alarm (Levels 1 and 2) until the operator acknowledges the alarm through the alarm manager. Each alarm shall require individual acknowledgement. The user shall be able to enable or disable an audible tone whenever a Level 1 or 2 alarm is reported, however, the alarm shall be visible and flashing on the active graphics page until acknowledged and shall remain stored in memory.

V. Scheduling Terminology: When equipment operation is scheduled throughout the day, the following defines the terminology used. Refer to specific control sequences for each system for identification of which modes apply.

1. Occupied Period: Scheduled period of time when the building, zone group, or zone is in use and occupied.

   a. Occupancy schedule shall be allowed to vary based on zone and space use. Zones shall be capable of being grouped based on primary occupancy type to facilitate assignment and management of occupancy schedules. A preliminary assignment of zone groups and occupancy schedules is provided below. Final schedule, grouping quantity, and grouping asssignments shall be confirmed and be customizable by the University.

2. Unoccupied Period: Scheduled period of time when the building, zone group, or zone is not in use and unoccupied.

   a. The unoccupied period will start at the end of the occupied period and end with the start of the pre-occupancy period.

3. Pre-occupancy Period: Time prior to the scheduled Occupied Period when the systems are returning the space temperatures from unoccupied to occupied setpoints (warm-up and cool-down).

   a. Time period shall be determined by an optimum start strategy unless otherwise specified.

Preliminary Zone Group Occupancy Schedules					
Zone Group	Example Spaces	Monday - Friday	Saturday	Sunday	Holiday
Student Access	Computer Areas, Study Areas, Lounges, Corridors, Grand Reading Room, Lookout, Group Study Rooms, Lobby	24 Hour	24 Hour	24 Hour	24 Hour
Department / Office	Offices, Digilab, Makerspace, Greenscreen	7:00 AM – 6:00 PM			
Classroom	Classrooms	7:00 AM – 6:00 PM			
Events	Events, Visualization Lab, Exhibit	7:00 AM – 12:00 AM	7:00 AM – 12:00 AM	7:00 AM – 12:00 AM	
Special Collections Archive (1)	Special Collections, SC Shell	24 Hour	24 Hour	24 Hour	24 Hour
Toilet (2)	Toilets	7:00 AM – 10:00 PM	7:00 AM – 10:00 PM	7:00 AM – 10:00 PM	7:00 AM – 10:00 PM

Notes:
1) Special Collections Archive occupancy mode only affects the ventilation and relief air terminal box operation. Temperature and humidity setpoints shall remain constant. Occupied mode initiated only upon occupancy sensor activation within the space.
2) Toilet exhaust fan shall operate at minimum code-required airflow during scheduled unoccupied hours.

4. Occupied Mode: Status when building, zone group, or zone is in use and occupied.

   a. Occupied mode shall initiate:

      1) At the start of each scheduled Occupied Period.
      2) When any space occupancy sensor associated with a zone detects occupancy and remain active until all space occupancy sensors associated with a zone do not detect occupancy for a period of 15 minutes (FA) (Occupancy Sensor Override). Refer to paragraph 3.6 for spaces with occupancy sensor integration.
      3) When overridden at the zone temperature sensor (where available) and remain active for a period of 2 hours (FA) (Occupant Override).
      4) When overridden at the BAS interface and remain active for an operator defined period of time, maximum of 2 hours (FA) (Operator Override).

   b. Systems serving zones in Occupied mode will be fully operational and ventilation air shall be continuously introduced.

   c. Space temperature setpoints will be in the “normal” range of 68°-77°F. Where space temperature sensors are specified with occupant adjustability, software limits shall be programmed to maintain setpoint within ranges specified above.

1) Special Collections setpoint shall be 68°F for cooling and 63°F for heating.

5. Occupied-Standby Mode: Status when space occupancy sensors associated with an Occupied zone no longer detect occupants but zone is not scheduled to be in Unoccupied Period.

a. Occupied-Standby status shall initiate when all space occupancy sensors (where available) associated with a zone do not detect occupancy for a period of 15 minutes (FA) and the zone is still scheduled in the Occupied Period. Refer to paragraph 3.6 for spaces with occupancy sensor integration.
b. Air handling unit supply and return fans and interlocked exhaust fans shall continue to operate continuously with ventilation and temperature setback in the spaces.
c. System ventilation rate will be reduced based on zones that are in Occupied-Standby.
d. Occupied-Standby setback temperatures shall be 77°F (FA) for cooling and 68°F (FA) for heating.

1) Special Collections setpoint shall not be adjusted.

6. Unoccupied Mode: Status when the building, zone group, or zone is not in use and unoccupied.

a. Unoccupied mode shall initiate:

1) At the scheduled end of the Occupied Period unless overridden to be in Occupied mode as defined above.
2) At the expiration of any Occupancy Overrides for zones not in the Occupied Period.

b. Air handling unit supply and return fans and interlocked exhaust fans shall continue to operate continuously with ventilation and temperature setback in the spaces.
c. System ventilation rate will be reduced based on zones that are Unoccupied.
d. Unoccupied setback temperatures shall be 80°F (FA) for cooling and 65°F (FA) for heating.

1) Special Collections setpoint shall not be adjusted.

7. Where occupancy scheduling is specified, each independent air handling system shall have its own user adjustable occupancy schedule programmed to the BAS.

3.2 EMERGENCY GENERATOR – CONTROL SEQUENCE

A. The emergency generator has a packaged combustion and safety automatic control system furnished by equipment manufacturer as specified in Section 263213 – ENGINE GENERATORS (issued in Package A).

B. This contractor shall provide control wiring to an auxiliary contact in generator control panel for monitoring equipment operation and alarms.

C. The BAS shall monitor the generator run status contacts and shall enunciate a message for logging purposes at the operator interface. BAS shall trend the status contacts to provide an archived history of generator run times. The BAS shall also accumulate run time.

D. The BAS shall monitor the generator alarm contacts and enunciate a critical (Level 1) alarm whenever an alarm condition occurs.

E. All equipment as indicated in schedules shall be fed from emergency (standby) power, along with its associated DDC control panels, electric valve and damper actuators, and instrumentation. All DDC panels shall be provided with an uninterruptible power supply (UPS) sized for 5 minute minimum capacity. Provide control wiring from contact in UPS to BAS for remote monitoring/alarming for trouble condition.

F. The emergency generator shall communicate with the Building Automation System via Modbus or Lon protocol.

3.3 EMERGENCY POWER OPERATING MODE - CONTROL SEQUENCE

A. During loss of primary power, emergency backup power will be provided for continued operation of critical equipment. A contact closure in any automatic transfer switch shall signify start of emergency operating mode. A secondary contact closure in the emergency generator control panel shall confirm operation of the generator.

B. The generator power operating sequence shall only be executed when normal power is lost and shall not be activated based on automatic transfer switch manually transferring to generator power. Regular testing of the generator system will start the generator and transfer loads to the generator without affecting the operation of equipment. The BAS shall continuously monitor contact(s) within all automatic transfer switches as well as the fire pump transfer switch to indicate presence of normal power. Operation of the emergency power system shall only occur when normal power is lost based on contact closure within automatic transfer switches.

C. Software programming by the Controls Contractor shall provide for sequential start-up of equipment. Contact switch closure / opening for emergency and normal power modes at each automatic transfer switch shall be used to sequence equipment operation through the BAS as follows:

1. Under closure of emergency contact in emergency power transfer switch, the following equipment shall be energized:

   a. DDC panels shall switchover from UPS.

2. Upon closure of emergency contact in equipment power transfer switch, the following equipment shall be energized in sequential order as listed below with a 10 second (FA) delay between each start. Equipment required to operate in parallel with other equipment shall be energized simultaneously with the other equipment.

   a. Emergency Electrical room conditioning:

      1) CU-2
      2) ACU-1-6
      3) ACU-1-5

   b. Fire Pump room heating:

      1) EH-1

   c. Special Collections conditioning:

      1) AHU-3 or AHU-4 (lead unit as determined by normal sequence operations)
      2) CU-3 or CU-4 (aligned with AHU above)
      3) AT-2103-4
      4) AT-2103-1
      5) AT-2094
      6) AT-2103-3
      7) AT-2103-2
      8) SG-1

   d. IDF, Electrical, and Security room conditioning:

      1) CU-1
      2) ACU-1-1
      3) ACU-1-2
      4) ACU-1-3

5) ACU-1-4
6) ACU-2-1
7) ACU-2-2
8) ACU-2-3
9) ACU-2-4
10) ACU-3-1
11) ACU-3-2
12) ACU-3-3
13) ACU-3-4

e. All other equipment not listed above shall remain de-energized in the emergency operating mode.

3. If any one of the automatic transfer switches is in emergency mode while another switch is in normal power mode, a critical (Level 1) alarm shall be generated through the BAS.

D. When normal power to the building resumes as proven by contact closure for normal power in all automatic transfer switches, the emergency operating mode shall end and normal sequences of control for mechanical equipment shall resume. Start-up of equipment for normal operating mode shall be in the same sequential order stated above. All other equipment which is required to be energized, but is not listed above, shall be energized after the equipment listed above with 10 second delays between equipment starts. Equipment operating in emergency mode which normally operates in a lead – lag arrangement with secondary equipment shall become indexed as the lead equipment through the BAS when normal power operation resumes. Equipment required to operate in parallel with other equipment shall be energized simultaneously with the other equipment.

3.4 MISCELLANEOUS CONTROL AND MONITORING POINTS

A. The BAS will capture energy and water consumption data from equipment provider by others. The BAS will record and trend the following. The trend will capture the monthy and annual consumption of each utility.

1. Water consumption in GPM and Gallons
2. Electrical power consumption in KWH and KW.

B. The following plumbing equipment shall be monitored for systems fault alarm:

1. Domestic Water Booster Pump
2. Domestic Water Heaters

C. The following plumbing equipment shall be monitored for general alarm:

1. Elevator Sump Pump

D. The following plumbing equipment shall be controlled:

1. Domestic Hot Water Recirculation Pump (Start/Stop)

3.5 VARIABLE FLOW REFRIGERANT (VRF) SPLIT AIR CONDITIONING UNITS (ACU/CU)

A. VRF split DX air conditioning systems are provided for year-round cooling of the electrical, telecommunications, security, and elevator machine rooms due to lack of chilled water service to the building as the regional chiller plant is shut down for a portion of the year. The evaporator coils are located in each of the spaces with the condensing units located in the 4th floor equipment room.

B. Each split DX air conditioning system has a packaged control system as specified in Section 23 8127 Variable Refrigerant Flow System Equipment.. This Contractor shall be responsible for installing and connecting controls required which are not factory installed and wired by equipment manufacturer.

C. The BAS shall continuously monitor temperature within the spaces and shall send a Level 3 alarm through the BAS whenever space temperature varies more than 5 degrees F (FA) from setpoint. Initial space temperature setpoint to be 85°F (FA) for electrical rooms, 75°F(FA) for elevator machine rooms, and 72°F(FA) for telecommunications rooms.

3.6 OCCUPNACY SENSOR INTEGRATION

A. Lighting control systems within designated rooms shall integrate with BAS through BACnet interface to allow for reduction of supply airflow to the space during unoccupied mode. Room occupancy status shall be an input to the BAS from the space occupancy sensor which is specified in Division 26. The occupancy status from the spaces listed below shall be used to register air terminal devices as occupied or unoccupied.

1. First Floor

   a. 1061 Greenscreen and Podcast
   b. 1062 Digi Lab
   c. 1062A Scanning
   d. 1064 Staff Office
   e. 1065 Makerspace
   f. 1070A Events Storage
   g. 1070B Staging
   h. 1072 Visualization Lab
   i. 1077F Group Study

2. Second Floor

   a. 2088 Classroom
   b. 2093 Open Collaboration
   c. 2093A Group Study
   d. 2093B Group Study
   e. 2094 Special Collections Shell (ventilation setback only)
   f. 2095 Special Collections Reading Room
   g. 2097 Classroom
   h. 2102 Staff Offices
   i. 2102B Director Office
   j. 2103 Special Collections (ventilation setback only)

3. Third Floor

   a. 3002 Open Seating
   b. 3009 Open Seating
   c. 3010 Study Carrels
   d. 3011 Computers
   e. 3012 Open Seating
   f. 3012A Open Seating Nook
   g. 3013 The Lookout
   h. 3014 Open Seating
   i. 3014A Open Seating Nook
   j. 3015 Computers
   k. 3016 Study Carrels
   l. 3017 Open Seating

B. Refer to Air Terminal Devices control sequences specified herein for additional requirements.

C. Refer to specification Section 260923 – Lighting Control Devices for additional lighting control system requirements.

3.7 HEATING HOT WATER SYSTEM - CONTROL SEQUENCE

A. General:

1. Heating hot water is generated at the regional heating plant on campus and distributed to the building in a primary / secondary / tertiary pumping arrangement with building circulation pumps located in the mechanical room on the first floor. The heating hot water system within the building will utilize a variable flow pumping arrangement. Two new tertiary hot water pumps, P-HW-1 through HW-2, piped in parallel and each sized for approximately 70% of total reheat and preheat system flow will circulate heating hot water for preheat coils in air handling units AHU-1 through AHU-2 as well as terminal unit heating coils and fan coil units located in the stairwells and mechanical rooms. The pumps operate in a lead / lag arrangement for normal operation. A variable frequency drive (VFD) located at each pump will modulate flow based on load conditions. The BAS will alternate which pump is lead / lag each week to balance run hours.
2. The differential pressure at the hot water bridge will measure loop differential pressure at the building. The differential pressure will be transmitted back to the Westside Central Energy Plant. The Westside Plant controls and graphics are to be upgraded to monitor the Randall Library Expansion differential pressure transmitter and add the Randal Library Expansion differential pressure to the Westside Plant pump speed controls.

B. Hot Water Pumps (P-HW-1 through P-HW-2) – Control Sequence

1. Hot water pumps P-HW-1 through P-HW-2 are piped in parallel with each sized for approximately 70% of preheat and reheat flow. The pumps operate in a lead-lag arrangement.
2. Definition of lead and lag pumps shall be manually definable through the BAS using a software selector switch.
3. Hot water pumps P-HW-1 through P-HW-2 shall be started and stopped automatically through the BAS. The pump with the lowest run hours shall be selected as the lead pump, the pump with the most hours will be selected as the lag pump. Each week (FA), the BAS will reselect the lead / lag pumps to balance run hours. The lead / lag sequence will remain for the entire week.
4. Current sensing at each pump motor shall be used to prove flow.
5. Whenever a pump does not start within 20 seconds (FA) of start command, or if operating pump fails as proven by current switch, or if VFD fails, the failed pump shall be rotated to standby and de-energized, a critical (Level 2) alarm shall be generated through the BAS, and the next pump shall be energized after a 30 second (FA) delay. The failed pump shall remain locked out until manually reset through the BAS.
6. Provide differential pressure transmitters with sensor located in the hot water supply and return piping as shown on plans that will provide a maximum setpoint for the VFD speed control. Initial setpoint for differential pressure transmitters shall be 10 PSIG (FA) and shall be coordinated during TAB work to be the lowest setpoint required to achieve design flow to all preheat coils and terminal heating devices with any one control valve operating at 90% open with all coils balanced to maximum scheduled flow.
7. The pump VFD shall modulate to maintain differential pressure setpoint as measured across the hot water supply and return piping as noted above. Valve position for hot water control valves associated with AHU-1 thru 2 and terminal reheat coils shall be continuously monitored through the BAS and shall be used to reset the differential pressure setpoint. The setpoint shall be updated in 0.5 PSIG (FA) increments at a 10-minute (FA) interval by polling the valve positions such that the new setpoint will result in the valve with the most demand for heating to be between 85%(FA) and 95%(FA) open.

8. On a drop in differential pressure below setpoint at any of the pressure sensing locations for 5 minutes (FA), the speed of the pump(s) shall increase simultaneously and in parallel (if more than one pump is operating) until differential pressure setpoint is maintained at all sensing locations. On rise in differential pressure above setpoint at all sensing locations, the speed of the pump(s) shall decrease simultaneously and in parallel (if more than one pump is operating) until differential pressure setpoint is maintained at any one sensing location.
9. The lag hot water pump shall be energized based lead pump speed. Whenever differential pressure setpoint in the hot water piping at any one pressure sensing location cannot be maintained with lead pump operating at 90% (FA) speed for 5 minutes (FA) or 99% (FA) for 1 minutes (FA), lag pump shall be energized and the lead pump shall reduce speed while the lag pump increases speed. Once both pumps are operating at the same speed, they shall operate in tandem at the same speed to share the load. On decreasing load, both pumps shall simultaneously slow their speed to maintain differential pressure setpoint at all pressure sensing locations. If both pumps are operating at 40% speed (FA) or below and pressure differential is above setpoint for 10 minutes (FA), the pump with the most accumulated runtime shall be de-energized and the other pump shall operate to maintain differential pressure setpoint.
10. Whenever a pump is started, the pump shall operate for a minimum of 15 minutes (FA) before the pump is allowed to stop. After a pump is de-energized, the pump shall not be enabled to re-start for a minimum of 5 minutes (FA).
11. Minimum pump speed shall be 25% or 15 Hz (FA).

C. Hot Water Blending Valve (V-HW-4) – Control Sequence:

1. A normally open two-way modulating valve located in the branch hot water return piping from the building shall modulate to maintain 110°F (FA) hot water setpoint (or below) as measured by a temperature sensor in the hot water return piping downstream of all the loads.

D. Hot Water Pump Bypass (V-HW-3) – Control Sequence:

1. Coupled Mode Operation:

   a. The building hot water system shall be coupled to the campus hot water system whenever there is demand for heating based on modulation of any control valve in the hot water system and any of the following occurs:

      1) With the lag pump de-energized, the lead pump operates at 40% speed (FA) or below and building pressure differential setpoint is above setpoint for 10 minutes (FA), and the building has been operating in De-Coupled Mode for at least 30 minutes (FA), or
      2) All hot water pumps (P-HW-1 through P-HW-2) and/or VFDs have failed.

   b. During Coupled Mode operation:

      1) All hot water pumps (P-HW-1 through P-HW-2) shall be de-energized, and
      2) The hot water pump bypass valve (V-HW-3) shall fully open, and
      3) The hot water blending valve (V-HW-4) shall be commanded to the full open position.

2. De-Coupled Mode Operation:

   a. The De-Coupled Mode is the normal mode of operation.
   b. The building hot water system shall be de-coupled from the campus hot water system whenever there is demand for heating based on modulation and the differential pressure setpoint in the hot water piping at any one pressure sensing location cannot be maintained during Coupled Mode operation for 5 minutes (FA).
   c. During De-coupled Mode operation:

      1) The hot water pumps shall energize and operate as described above, and
      2) The hot water pump bypass valve (V-HW-3) shall fully close, and

3) The hot water blending valve (V-HW-4) shall operate as described above.

E. Emergency Hot Water Supply

1. The building hot water system shall be commanded to Coupled Mode operation when connected to an emergency portable hot water generator skid complete with its own pump.

F. High Pressure Alarm

1. A Level 2 alarm shall be generated at the BAS whenever the pressure sensor downstream of the building heating hot water pumps registers above 120 psig (FA) for 5 minutes (FA).

3.8 CHILLED WATER SYSTEM - CONTROL SEQUENCE

A. General:

1. Chilled water is generated at the regional heating plant on campus and distributed to the building in a variable primary / secondary pumping arrangement with building circulation pumps located in the mechanical room on the first floor. The chilled water system within the building will utilize a variable flow pumping arrangement. Two new secondary chilled water pumps, P-CHW-1 through CHW-2, piped in parallel and each sized for approximately 70% of total system flow will circulate chilled water for coling coils in air handling units AHU-1 through AHU-2 as well as terminal cooling devices located in the stairwells and mechanical rooms. The pumps operate in a lead / lag arrangement for normal operation. A variable frequency drive (VFD) located at each pump will modulate flow based on load conditions. The BAS will alternate which pump is lead / lag each week to balance run hours.
2. The differential pressure at the chilled water bridge will measure loop differential pressure at the building. The differential pressure will be transmitted back to the Westside Central Energy Plant. The Westside Plant controls and graphics are to be upgraded to monitor the Randall Library Expansion differential pressure transmitter and add the Randall Library Expansion differential pressure to the Westside Plant pump speed controls.

B. Chilled Water Pumps (P-CHW-1 through P-CHW-2) - Control Sequence:

1. Chilled water pumps P-CHW-1 through P-CHW-2 are piped in parallel with each sized for approximately 70% of the total chilled water flow. The pumps shall operate in a lead-lag arrangement.
2. Definition of lead and lag pumps shall be manually definable through the BAS using a software selector switch.
3. Chilled water pumps (P-CHW-1 through P-CHW-2) shall be started and stopped automatically based on outside air temperature as sensed by the building's outside air sensor. The pump with the lowest run hours shall be selected as the lead pump, the pump with the most hours will be selected as the lag pump. Each week (FA), the BAS will reselect the lead / lag /standby pumps to balance run hours. The lead / lag sequence will remain for the entire week.
4. Whenever outside air temperature is above 52°F (FA) or the regional plant signals the termination of the airside economizer cycle, the lead chilled water pump shall be started and flow proven via current sensing at the pump motor. Chilled water pumps shall not be allowed to operate when outside air temperature is below 52°F (FA). Whenever a chilled water pump is energized, the two-way control valve in the pump bypass line shall be closed.
5. Current sensing at each pump motor shall be used to prove flow.
6. Whenever a pump does not start within 20 seconds (FA) of start command, or if operating pump fails as proven by current switch, or if VFD fails, the failed pump shall be rotated to standby and de-energized, a critical (Level 2) alarm shall be generated at the BAS, and the next pump shall start after a 30 second (FA) delay. The failed pump shall remain locked out until manually reset through the BAS.

7. Provide differential pressure transmitters with sensor located in the chilled water water supply and return piping as shown on plans that will provide a maximum setpoint for the VFD speed control. Initial setpoint for differential pressure transmitters shall be 10 PSIG (FA) and shall be coordinated during TAB work to be the lowest setpoint required to achieve design flow to all coiling coils and terminal cooling devices with any one control valve operating at 90% open with all coils balanced to maximum scheduled flow.
8. The pump VFD shall modulate to maintain differential pressure setpoint as measured across the chilled water supply and return piping as noted above. Valve position for chilled water control valves associated with AHU-1 thru 2 and terminal cooling coils shall be continuously monitored through the BAS and shall be used to reset the differential pressure setpoint. The setpoint shall be updated in 0.5 PSIG (FA) increments at a 10-minute (FA) interval by polling the valve positions such that the new setpoint will result in the valve with the most demand for cooling to be between 85%(FA) and 95%(FA) open.
9. On a drop in differential pressure below setpoint at any of the pressure sensing locations for 5 minutes (FA), the speed of the pump(s) shall increase simultaneously and in parallel (if more than one pump is operating) until differential pressure setpoint is maintained. On a rise in differential pressure above setpoint at all sensing locations, the speed of the pump(s) shall decrease simultaneously and in parallel (if more than one pump is operating) until differential pressure setpoint is maintained at any one sensing location.
10. The lag chilled water pump shall be energized based on lead pump speed. Whenever differential pressure setpoint in the chilled water piping at any one pressure sensing location cannot be maintained with lead pump operating at 90% (FA) speed for 5 minutes (FA) or 99% (FA) for 1 minutes (FA), lag pump shall be energized and the lead pump shall reduce speed while the lag pump increases speed. Once both pumps are operating at the same speed, they shall operate in tandem at the same speed to share the load. On decreasing load, both pumps shall simultaneously slow their speed to maintain differential pressure setpoint at all pressure sensing locations. If both pumps are operating at 40% speed (FA) pressure differential is above setpoint for 15 minutes (FA), the pump with the most accumulated runtime shall be de-energized and the other pump shall operate to maintain differential pressure setpoint.
11. Whenever a pump is started, the pump shall operate for a minimum of 15 minutes (FA) before the pump is allowed to stop. After a pump is de-energized, the pump shall not be enabled to re-start for minimum of 5 minutes (FA).
12. Minimum allowable pump speed is 25% or 15 Hz (FA).

C. Chilled Water Blending Valve (V-CHW-4) – Control Sequence:

1. A normally open two-way modulating valve located in the chilled water return piping from the building shall modulate to maintain 58°F (FA) chilled water setpoint as measured by a temperature sensor in the chilled water return piping downstream of the building bypass bridge.
2. The blending valve shall be disallowed to modulate further closed if the chilled water supply temperature downstream of the building bypass bridge reaches 48°F (FA).

D. Chilled Water Pump Bypass (V-CHW-3) – Control Sequence:

1. Coupled Mode Operation:

   a. The building chilled water system shall be coupled to the campus chilled water system whenever there is demand for cooling based on modulation of any control valve in the hot water system and any of the following occurs:

      1) With the lag pump de-energized, the lead pump operates at 40% speed (FA) or below and building pressure differential setpoint is above setpoint for 10 minutes (FA), and the building has been operating in De-Coupled Mode for at least 30 minutes (FA).
      2) All chilled water pumps (P-CHW-1 through P-CHW-2) and/or VFDs have failed.

b. During Coupled Mode operation:

1) All chilled water pumps (P-CHW-1 through P-CHW-2) shall be de-energized, and
2) The chilled water pump bypass valve (V-CHW-3) shall fully open, and
3) The chilled water blending valve (V-CHW-4) shall be commanded to the full open position.

2. De-Coupled Mode Operation:

a. The De-Coupled Mode is the normal mode of operation.
b. The building chilled water system shall be de-coupled from the campus chilled water system whenever there is demand for cooling based on modulation and the differential pressure setpoint in the chilled water piping at any one pressure sensing location cannot be maintained during Coupled Mode operation for 5 minutes (FA).
c. During De-coupled Mode operation:

1) The chilled water pumps shall energize and operate as described above, and
2) The chilled water pump bypass valve (V-CHW-3) shall fully close, and
3) The chilled water blending valve (V-CHW-4) shall operate as described above.

E. Emergency Chilled Water Bridge Control (Coupled Mode)

1. The building chilled water system shall be commanded to Coupled Mode operation when connected to an emergency portable chilled water skid complete with its own pump.

F. High Pressure Alarm

1. A Level 2 alarm shall be generated at the BAS whenever the pressure sensor downstream of the building chilled water pumps registers above 155 psig (FA) for 5 minutes (FA).

3.9 ELECTRIC UNIT HEATERS – CONTROL SEQUENCE

A. Unit mounted thermostat shall cycle unit fan motor and electric coil to maintain space setpoint temperature. Space temperature setpoint shall be 60°F (FA) in spaces without fan coils or 5°F(FA) below the fan coil heating setpoint in spaces with fan coils.

B. The BAS shall continuously trend space temperature and send a critical (Level 2) alarm whenever space temperature drops below 40°F (FA).

3.10 FAN COIL UNITS - CONTROL SEQUENCE

A. Space temperature sensor shall energize supply fan and

1. Modulate 2-way control valve (FO) on hot water coil required to maintain space temperature setpoint, or
2. Modulate 2-way control valve on cooling coil (FC) as required to maintain 55°F (FA) discharge air temperature and cycle fan as required to space temperature setpoint.

B. Heating and cooling valves shall be sequenced so that cooling valve shall not open until heating valve is closed and vice versa.

C. The space temperature setpoint shall be as follows:

1. For stairwells, setpoint is 75°F (FA) for summer and 70°F (FA) for winter
2. For first floor MER and fourth floor, setpoint is 80°F (FA) for summer and 60°F (FA) for winter
3. Normal space cooling setpoint shall be space temperature +/- 2°F (FA)

4. Normal space heating setpoint shall be space temperature +/-2°F (FA)

D. Fan coil units in mechanical spaces shall be provided with a secondary drain pan with float switch hard-wired to fan starter. When float switch is activated (i.e.: high water level in secondary drain pan) the unit fan shall be de-energized, the chilled water valve shall be commanded closed and a critical (Level 2) alarm shall be generated at the BAS.

E. Fan coil units located in stairwells shall have a moisture sensor located in the overflow drain connection and hard wired to the fan starter shall de-energize unit fan, close chilled water valve, and signal a critical (Level 2) alarm through the BAS whenever moisture is sensed.

3.11 AIR TERMINAL DEVICES - CONTROL SEQUENCE

A. General:

1. Space temperature and ventilation control shall be through the DDC system as defined in sequences which follow.
2. Control Contractor shall furnish unit actuators to air terminal device manufacturer for factory installation and adjustment for all air terminal devices.
3. All regulators are system pressure independent type.
4. Control system shall be capable of remote setpoint modification of space temperature, and minimum and maximum airflow rates for each supply terminal.
5. Provide 24-volt electrical wiring and associated devices to each regulator as required to accomplish specific function. On loss of normal power, all electronic actuators on supply air terminal devices shall fail in last position.
   a. Air terminal devices AT-SA2103 and AT-RA2103 (providing ventilation/pressurization for the Special Collections AHU-3 & 4) shall fail closed upon loss of normal power.
6. Where more than one supply air terminal device serves a room, each air terminal shall be provided with a discharge air temperature sensor for control of the associated reheat coil control valve (for hot water coils) or SCR controller (for electric coils) to maintain discharge air setpoint. The discharge air temperature setpoint shall be reset by the space temperature sensor as required to meet space temperature setpoint.
7. Provide discharge air temperature sensor mounted in the discharge air duct downstream of each supply air terminal device as detailed. For spaces served by a single supply air terminal, the discharge temperature sensor shall be used for maintenance troubleshooting. For spaces served by more than one supply air terminal, the discharge temperature sensor shall have active control as described above.
8. For spaces noted on drawings to have interlock to occupancy sensor, this contractor shall provide control wiring and any auxiliary devices required to interface with the controller on the air terminal box(es) serving that room.
9. Reheat coil control valves shall close whenever associated air handling units are de-energized.
10. Where more than one thermostat is shown in spaces served by a single air terminal device, the control system shall average the space temperature measurements and provide a single output for control of the reheat coil control valve.

B. Air Terminal Diagnostics

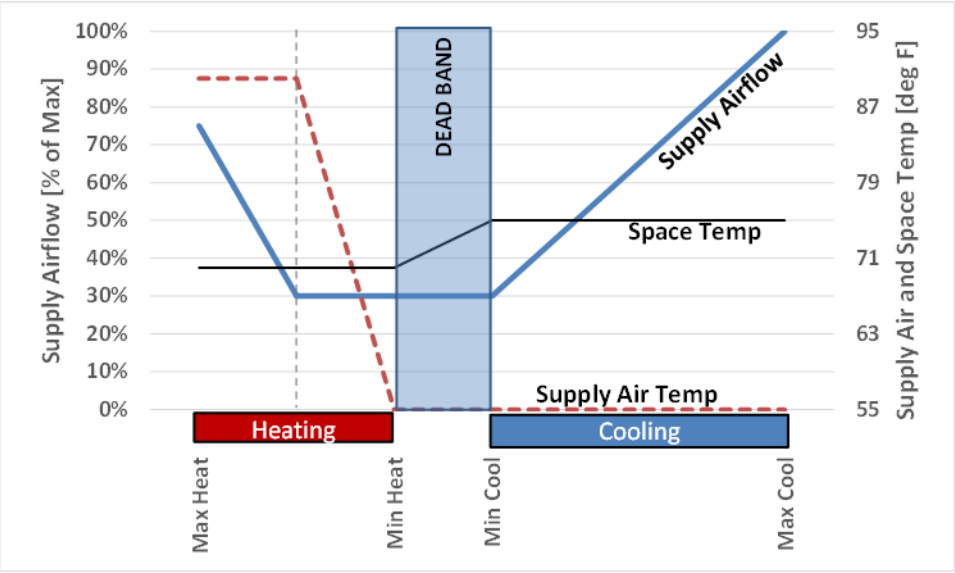
1. The BAS shall continuously trend air terminal damper positions and shall signal a Level 3 maintenance alarm whenever a supply air terminal damper is open more than 90%(FA) for more than 12 hours(FA).
2. The BAS shall monitor reheat valve position and signal a Level 3 maintenance alarm whenever a reheat valve is in closed position and discharge temperature leaving reheat coil rises more than 2°F (FA) for 30 minutes (FA).

3. The BAS shall continuously monitor discharge air temperature and space temperatures and signal the following alarms:

   a. High Supply Air Temp (5°F greater than current room setpoint) in cooling mode.
   b. Low Supply Air Temp (5°F less than current room setpoint) in heating mode.

C. Single Duct Variable Volume Supply Regulator with Reheat Coils:

1. Space temperature sensor shall modulate electric motor on box damper in a PI loop to control volume of supply air from full capacity to minimum quantities as indicated in schedules by cooling demand. On continued drop in space temperature, temperature sensor shall modulate automatic control valve (fail last position) on hot water reheat coil (or electric output on electric reheat coil) to maintain space temperature setpoint of 70°F(FA) winter or 75°F (FA) summer. Summer and winter setpoints shall be defined through programmed schedule in the BAS.
2. Setpoint Adjustment: Occupant shall have the capability to adjust the setpoint temperature +1.5°F to -1.5°F from the setpoint temperature in the BAS.
3. With rise in space temperature, the reverse sequence shall occur with reheat control valve closing (or electric coil de-energizing) first followed by modulation of air terminal device.
4. Dual Maximum Control (i.e. different heating and cooling maximum airflow): For units requiring dual maximum control per the terminal box schedule, space thermostat shall modulate electronic actuator to control volume of supply air from full capacity to minimum quantities as indicated in schedules by cooling demand. On continued drop in space temperature, thermostat shall modulate automatic control valve on hot water reheat coil to maintain space temperature. Discharge air temperature off the hot water coil shall be limited to 85°F (FA). If supply air temperature reaches 85°F (FA) at minimum air flow and more heating capacity is required to meet space temperature setpoint, then the terminal box shall increase the airflow while maintaining 85°F (FA) discharge air temperature until the space setpoint is satisfied, up to the maximum terminal box heating airflow as listed in the terminal box schedule. This dual maximum control strategy is illustrated below, but refer to written sequence and terminal box schedule for exact setpoints which will differ from this general diagram. Deadband is shown on diagram where space temperature is between heating and cooling setpoints, so there is no demand for heating or cooling in this range of space temperature. Contractor shall adjust 85°F limit according to leaving air temperature listed in air terminal schedule.



5. Occupied Mode Operation:

   a. Supply air damper shall modulate between its scheduled occupied minimum and maximum cooling or heating values as described above to maintain Occupied temperature setpoints.

b. The following values shall be used to calculate zone ventilation airflow *Voz*:

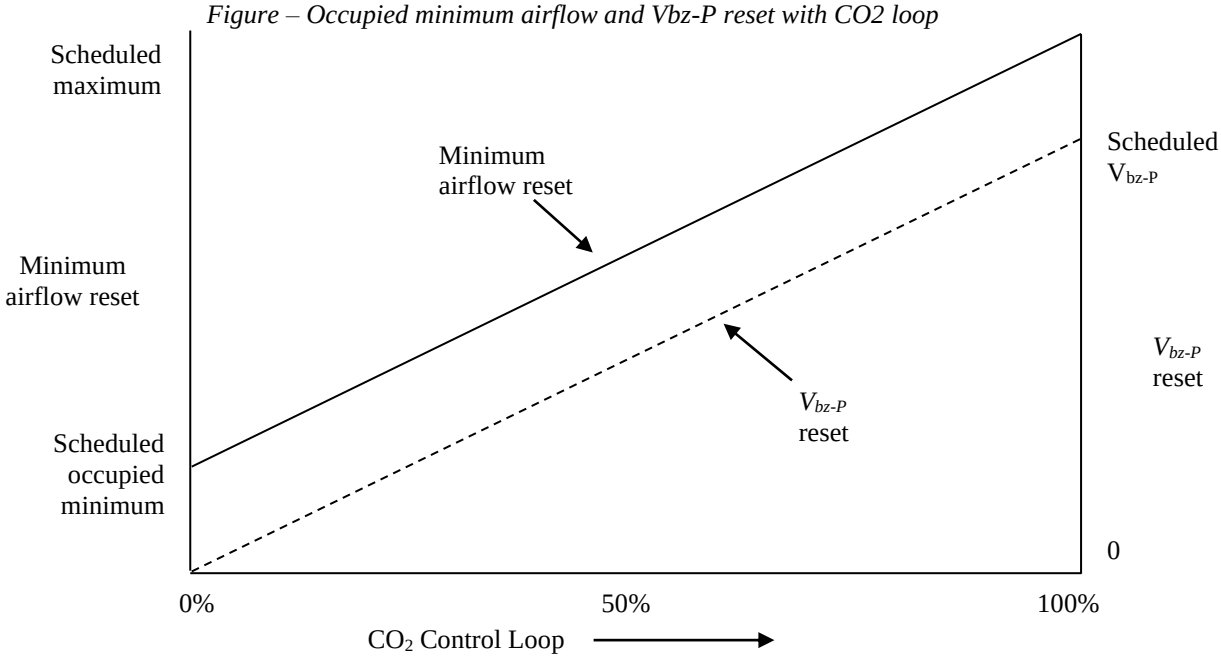
1) Population component *Vbz-P* = value listed in air terminal schedule
2) Area component *Vbz-A* = value listed in air terminal schedule

c. If the zone is scheduled for CO2 sensor integration:

1) A P-only loop shall maintain CO2 concentration at setpoint; reset from 0% at setpoint minus 200 PPM (FA) and to 100% at setpoint. See table below for default CO2 setpoints based on occupancy type. Setpoints shall be adjustable.
2) The CO2 control loop shall reset both the occupied minimum airflow setpoint and ventilation airflow population component *Vbz-P* in parallel. Occupied minimum airflow shall be reset from the scheduled occupied minimum airflow at 0% loop output up to maximum cooling airflow at 100% loop output. *Vbz-P* shall be reset from 0 cfm at 0% loop output up to the scheduled Vbz-P value at 100% loop output. See figure below.

Default CO2 Setpoints per ASHRAE Standard 62.1			
Occupancy Category	CO_2 Setpoint (ppm)	Occupancy Category	CO_2 Setpoint (ppm)
Educational Facilities		Public Assembly Spaces	
Computer Lab	965	Libraries	805
Multiuse Assembly	1,778	Lobbies	2,628
		Museum/Galleries	1,620

Figure – Occupied minimum airflow and Vbz-P reset with CO2 loop



6. Occupied-Standby Mode Operation:

a. Supply air damper shall be allowed to modulate to its scheduled unoccupied minimum value and up to its maximum cooling or heating value as described above to maintain Occupied-Standby temperature setpoints.

b. The following values shall be used to calculate zone ventilation airflow *Voz*:

1) Population component *Vbz-P* = 0
2) Area component *Vbz-A* = value listed in air terminal schedule

7. Unoccupied Mode Operation:

a. Supply air damper shall be allowed to modulate to its scheduled unoccupied minimum value and up to its maximum cooling or heating value as described above to maintain Unoccupied temperature setpoints.
b. The following values shall be used to calculate zone ventilation airflow *Voz*:

1) Population component *Vbz-P* = 0
2) Area component *Vbz-A* = 0

8. Zone Ventilation Airflow *Voz*:

a. For compliance with the Ventilation Rate Procedure of ASHRAE Standard 62.1-2016, outdoor air and zone minimum setpoints shall be calculated as follows:

1) Determine zone air distribution effectiveness *Ez*.

a) If the air terminal discharge air temperature is less than or equal to zone space temperature, *Ez* shall be equal to scheduled *EzC* (default to 1.0 if no value is scheduled).
b) If the air terminal discharge air temperature is greater than zone space temperature, *Ez* shall be equal to *EzH* (default to 0.8 if no value is scheduled).

2) Breathing zone ventilation population and area components *Vbz-P* and *Vbz-A* shall be determined based on occupancy mode as described above.
3) The required zone outdoor airflow *Voz* shall be calculated as:

a) $Voz = (Vbz\text{-}A + Vbz\text{-}P)/Ez$

b. Calculated *Voz* values shall be used to determine air handling system minimum outdoor airflow setpoint.

D. Single Duct Variable Volume Supply Regulator without Reheat Coils:

1. Space temperature sensor shall modulate electric motor on box damper in a PI loop to control volume of supply air from full capacity to minimum quantities as indicated in schedules by cooling demand. On continued drop in space temperature, box damper shall close completely and remain closed.
2. Setpoint Adjustment: Occupant shall have the capability to adjust the setpoint temperature +1.5°F to -1.5°F from the setpoint temperature in the BAS.
3. With rise in space temperature, the reverse sequence shall occur with box damper opening to minimum position first followed by modulation of air terminal device.
4. Occupied Mode Operation:

a. Supply air damper shall modulate between its scheduled occupied minimum and maximum cooling values as described above to maintain Occupied temperature setpoints.

5. Occupied-Standby Mode Operation:

a. Supply air damper shall be allowed to modulate to its scheduled unoccupied minimum value and up to its maximum cooling value as described above to maintain Occupied-Standby temperature setpoints.

6. Unoccupied Mode Operation:

   a. Supply air damper shall be allowed to modulate to its scheduled unoccupied minimum value and up to its maximum cooling value as described above to maintain Unoccupied temperature setpoints.

7. Zone Ventilation Airflow *Voz*:

   a. Supply air terminals without reheat coils are only used in zones where they are paired with an air terminal with a reheat coil (Computing, West Lobby, and Events). In these zones, the air terminals with reheat coils are sized to provide code required ventilation air. Air terminals without reheat coils shall not affect ventilation calculations.
   b. Supply air terminals without reheat coils shall not have any airflow resets based on CO2 sensor integration.

E. Single Duct Variable Volume Supply Regulator for Pressurization/Relief (AT-SA2103, AT-RA-2103):

1. Occupancy sensor(s) associated with air terminal units shall modulate electric motor on box damper to control the volume of supply air from full capacity to minimum quantities as indicated in schedules and below.
2. The dampers in air terminals providing ventilation/pressurization and relief for the Speical Collections archive shall modulate to their maximum value whenever the air terminal is registered as Occupied, and modulate to their minimum unoccupied value whenever the air terminal is registered as Unoccupied. The air terminals shall be registered as unoccupied when all occupancy sensors within the Special Collections and SC Shell do not detect occupancy for 15 minutes (FA). The air terminals shall be registered as occupied when any single occupancy sensor within the Special Collections or SC Shell detects occupancy.

   a. AT-RA2103 relief airflow during Occupied Mode shall be equal to the AT-SA2103 supply airflow minus a fixed Archive Pressurization airflow. AT-SA2013 supply airflow during Occupied Mode shall be equal to the maximum scheduled value for occupied operation.
   b. AT-SA2103 supply airflow during Unoccupied Mode shall be equal to the AT-RA2103 relief airflow plus a fixed Archive Pressurization airflow. AT-RA2103 relief airflow during Unoccupied Mode shall be equal to the minimum scheduled value for unoccupied operation.
   c. Archive Pressurization airflow shall be determined by the balance contractor to maintain a slightly positive archive pressurization relative to the adjuacent spaces (+.03" WC). The flow sensor/transmitters shall provide continuous measurement of the supply and relief airflow through the BAS.

3.12 AIR HANDLING UNIT DIAGNOSTICS

A. Diagnostic Strategies: In addition to the standard alarm limits specified for all sensed variables, the BAS shall monitor and diagnose anomalies in the operation of the air handlers. The following “diagnostic strategies” shall be included for each AHU.

1. Run Time Limit: BAS shall accumulate the runtime of the status of associated rotating equipment and enunciate a Level 3 alarm to indicate that the unit is in need of service whenever operating hours exceed 5,000 hrs (FA).
2. Filter Monitoring: BAS shall monitor the differential pressure across the filter bank(s). A Level 3 alarm shall be reported when pressure drop exceeds differential pressure setpoint.
3. Start Monitoring: BAS shall accumulate the starts of cycling equipment. BAS shall further enunciate a Level 3 alarm when the number of starts exceeds the specified value within the specified time period. Number of starts and time period shall be adjustable. Initial setpoint shall be 3 starts in a 30-minute period.
4. Heating Valve Leak: While heating valve is closed, if the temperature increase across the heating coil exceeds 2°F continuously for 30 minutes; or if the discharge temperature is more than 5°F

above setpoint for more than 30 minutes continuously, enunciate the following alarm at level 3 priority:

a. ENERGY WASTE: An unexpected temperature rise is occurring across the heating coil. Please check for leaking valve or faulty controls.

5. Cooling Valve Leak: While cooling valve is closed, if the temperature drop across the cooling coil exceeds 2°F continuously for 30 minutes; or if the discharge temperature is more than 2°F below setpoint for more than 30 minutes continuously, enunciate the following alarm at level 3 priority:

a. ENERGY WASTE: An unexpected temperature drop is occurring across the cooling coil. Please check for leaking valve or faulty controls.

6. Economizer Anomaly: If mixed air temperature is less than 45°F (FA) or greater than 85°F (FA); or if the outside air temperature is between 55°F and 65°F and the mixed air temperature is more than 2°F different from the outside air temperature for more than 30 minutes continuously, enunciate the following alarm at level 3 and 4 priority:

a. ENERGY WASTE: An unexpected mixed air temperature indicates a possible problem with the economizer damper controls. Please check for faulty dampers or controls.

7. Fighting Valves: BAS shall monitor the valve positions of the preheat and cooling coils and shall enunciate the following level 3 alarm if the valve positions are both over 10% open.

a. Fighting Valves: The preheat and the cooling valves are opening simultaneously. Coordinate the control loops.

8. The BAS shall be configured to trend the following additional parameters:

a. Space temperature sensors at 1-hour (FA) intervals
b. Static pressure sensors at 1-hour (FA) intervals
c. Equipment run requests and status on change of value
d. Building pressure differential measurements on 15-minute (FA) intervals

3.13 AIR HANDLING UNIT (AHU-1, 2) - CONTROL SEQUENCE

A. General:

1. System is designed as cooling and heating, single duct, variable volume reheat system.
2. System is designed for minimum and maximum outside air with an economizer control.
3. System fans consist of a semi-custom air handling unit fan array system with four (4) supply fans and four (4) return air fans. Each fan is provided with a mechanical backdraft damper on the fan inlet and ECM motors.
4. AHU-1 and AHU-2 are headered together and share supply and return air plenums.

B. Unit Operating Mode:

1. System shall operate all the time with single operating mode.
2. In addition to the normal operating mode, system shall be provided with a manually activated increased ventilation (contaminant purge) mode.
3. BAS shall program time initiated functions and other items as specified.
4. Control Contractor shall provide all necessary devices such as relays required for interface.
5. System is also provided with Smoke / Fire Alarm Shutdown Mode as outlined in separate section.

C. Unit Operation:

1. Unit operation shall be automatic and activated through the building automation system.
2. Current sensing shall be used to prove fan operation. Failure of one or more supply or return fans shall result in a critical (Level 2) alarm activated through the BAS.

3. If supply or return fans are signaled to start and fan(s) does not start within 20 seconds (FA) of start command, or if operating fan(s) fails based on motor current switch, failed fan(s) shall be de-energized and a critical (Level 2) alarm shall be generated through the BAS. The failed fan shall remain locked out until manually reset through the BAS.
4. If all of the supply fans in the air handling unit fail to operate when commanded to start, the outside air damper and relief air damper for the unit shall close in addition to requirements specified above.

D. Interlocking:

1. The return fans shall be interlocked via software with supply fans so that the return fans operate simultaneously and in parallel whenever supply fans operate and shall stop whenever all supply fans stop. Return fans shall start momentarily after associated supply fans are allowed to start. Interlocking of fans shall be based on system rather than individual fans.
2. Fan failure is determined from current switch on each fan motor.
3. Interlock smoke/isolation dampers on unit discharge and entry with supply fans so that dampers are proven open by limit switch prior to fan start signal.

E. Occupied and Unoccupied Operation:

1. System does not require occupied-unoccupied operation. System shall operate continuously with outside air damper open. Outside air damper shall close whenever all unit supply fans are de-energized.
2. A flow sensor / transmitter shall be installed in the outside air ductwork to provide continuous measurement of outside air through the BAS. A low flow (Level 2) alarm shall be signaled through the BAS whenever outside air drops below minimum scheduled amount for 15 minutes (FA).

F. System Air Volume Control:

1. Each unit supply and return fan has an ECM motor for system air volume control. Control system shall be configured so that all fans in a fan array operate at the same speed based on static pressure signals defined below. On failure of a fan, the remaining operational fans in the fan array shall increase speed in parallel to meet the static pressure setpoint.
2. Arrange controls so that fans shall always start at low speed.
3. Fan speed for all fans in array shall be modulated in parallel from common static pressure signal. Duct static pressure shall be measured with pressure transmitters located in supply duct as shown on plans. On a drop in static pressure below setpoint, as measured by any of the respective pressure sensors/transmitters associated with the air handling unit, the speed of all operating supply fans shall increase simultaneously and in parallel until static pressure setpoint has been satisfied at all pressure sensing locations associated with that system. On rise in static pressure above setpoint of all system static pressure sensors for the air handling system, the speed of all operating supply fans shall decrease simultaneously and in parallel until the setpoint of any one pressure sensor/transmitter associated with the system is satisfied. Static pressure setpoint shall be modified automatically through the BAS based on VAV box damper position. The BAS shall monitor all terminal box damper positions every 10 minutes (FA) and update static pressure setpoint.
4. Provide appropriate electrical signal input to volume control devices and necessary devices such as a transducer.
5. Control Contractor shall work in association with Test and Balance Contractor to determine actual required static pressure setpoints. Actual static pressure setpoints shall be minimum pressure required to achieve design airflow.
6. Locate static pressure sensors in supply duct near the end of the system as shown on plans. Initial setpoint for static pressure transmitters shall be 1.5” wg (FA) and shall be coordinated during TAB work to be the lowest setpoint required to achieve design flow to all air terminals on the system

with any one air terminal damper operating at 95% open with all spaces balanced to maximum scheduled flow rates.

G. Unit Discharge Air Temperature Control:

1. Unit discharge air controller shall modulate control valve on cooling coil to maintain discharge air temperature. Discharge air temperature shall be reset from a high of 65°F(FA) to a low of 55°F(FA) based on maintaining space temperature in all spaces. Discharge air temperature setpoint shall drop in 1°F (FA) increments as air terminal boxes are in full cooling and space temperature can be maintained for 5 minutes (FA). Discharge air temperature shall rise in 1°F(FA) increments whenever 90%(FA) of air terminal reheat control valves are open for 5 minutes (FA).
2. Whenever cooling coil control valve is modulated open and outside air temperature is below 50°F (FA), a Level 2 alarm shall be generated at the BAS.
3. Cooling coil control valve shall be closed whenever all unit supply fans are not operating or whenever preheat valve is open except both valves shall open on freezestat trip.

H. Preheat Coil Discharge Temperature Control:

1. Preheat coil discharge air controller with sensor located immediately downstream of preheating coil shall modulate 2-way control valve serving preheating coils to maintain setpoint of 3°F(FA) below discharge air temperature setpoint.

I. Return Air Mixing Damper Control:

1. When not in economizer mode, the return air damper shall modulate to maintain minimum ventilation outside airflow setpoint as measured by the airflow measuring station located within the outside air intake duct and noted in AHU schedule.

J. Relief Air Damper Control:

1. A static pressure controller with its static pressure sensing station downstream of the return fans shall modulate relief air damper to maintain static pressure setpoint of +0.2 inch wg (FA).
2. The relief air damper shall close if all associated return fans are de-energized.
3. Interlock attic relief damper operation with AHU unit relief damper. When either AHU-1 or AHU-2 relief damper is open, the building relief air dampers shall be open. When both AHU relief dampers are closed, the building relief air dampers shall be closed.

   a. Attic relief dampers shall also be capable of opening if the attic temperature as sensed by FCU-4 exceeds 105°F (FA). Attic relief dampers shall close when the FCU-4 temperature sensor is less than 95°F (FA) for 5 minutes (FA).

K. Outside Air Damper Control:

1. When AHU is operating in any occupied mode and supply fans are energized, outside air damper shall remain fully open. Outside air volume shall be controlled by modulating the return air damper.
2. Outside air damper shall close whenever all unit supply fans are de-energized.

L. Economizer Control:

1. The BAS acting through the mixed air temperature controller shall modulate the RA damper to provide “free cooling” when outside air temperature and relative humidity merit. The BAS will receive signal from the regional energy plant when economizer operation is permitted; the building shall not put itself into economizer mode.
2. When economizer mode is active, the return air damper shall be modulated to maintain mixed air temperature at setpoint of 3°F (FA) below unit discharge setpoint.

M. Return Fan Control:

1. Each unit return fan is furnished with a ECM motor for system air volume control. Control system shall be arranged so that all return fans shall operate simultaneously and in parallel at the same speed based on static pressure signals as defined below. On failure of a return fan, all fans in the fan array shall increase speed in tandem to meet the static pressure setpoint.
2. Return fans shall use flow tracking control to maintain the correct return fan airflow. The return airflow shall be equal to the supply airflow minus the exhaust airflow minus a fixed building pressurization airflow. The building pressurization airflow shall be determined by the balance contractor to maintain a slightly positive building pressurization relative to outdoors (+.03" WC, FA). The flow sensor/transmitters shall provide continuous measurement of the supply, return, exhaust and outside air through the BAS.
3. Arrange controls so that fans shall always start at low speed. On failure of a fan volume control signal, respective fan shall go to low speed and stop.
4. Provide appropriate electrical signal input to speed control device and necessary devices such as transducer.
5. Return fans shall be interlocked via software interlock with associated air handling unit supply fan as described in AHU control sequence.
6. Return fans shall be started and stopped automatically through the BAS and shall operate whenever associated supply fans operate in normal operating mode.
7. Current sensing at each fan motor shall be used to prove flow.
8. If return fans are signaled to start and fan(s) does not start within 20 seconds (FA) of start command, or if operating fan fails based on motor current switch, fan(s) shall be de-energized, and a critical (Level 2) alarm shall be generated at the BAS. The failed fan(s) shall remain locked out until manually reset through the BAS.

N. Minimum Outdoor Airflow Setpoint

1. Outdoor Airflow Setpoint for ASHRAE Standard 62.1-2016 Ventilation

   a. Zone outdoor air requirement *Voz* shall be calculated as described in Section 3.11.
   b. Design outdoor rates for the combined AHU-1,2 system as calucated using the ASHRAE 62.1 Multizone Calculation are as follows:

      1) Uncorrected Design Outdoor Air Rate *DesVou* = 15,250 CFM
      2) Design Total Outdoor Air Rate *DesVot* = 18,500 CFM

   c. The uncorrected outdoor air rate setpoint *Vou* is recalculated continuously based on the adjusted ventilation rates *Vbz-A* and *Vbz-P* of the zones being served determined in accordance with Section 3.11.

      1) Calculate the uncorrected outdoor air rate *Vou* for all zones served by air handling system, but note that *Vou* shall be no larger than the design uncorrected outdoor air rate *DesVou*.

$$Vou = \text{MIN}\ (\ DesVou\ |\ (\ \sum Vbz\text{-}A + \sum Vbz\text{-}P\ )\ )$$

   d. *Vps* is the sum of the zone primary airflow rates *Vpz* as measured by VAV boxes for all zones served by air handling system.
   e. For each zone in Occupied Mode, calculate the zone primary outdoor air fraction Zpz:

$$Zpz = Voz\ /\ Vpz$$

   f. Calculate the maximum zone outdoor air fraction *Zp*:
   g. Calculate the current system ventilation efficiency *Ev*:

$$Ev = 1 + (\ Vou\ /\ Vps\ ) - Zp$$

   h. Calculate the effective minimum outdoor air setpoint *MinOAsp* as the uncorrected outdoor air intake divided by the system ventilation efficiency, but no larger than the design total

outdoor air rate *DesVot*, and no less than the current exhaust airflow *Vex* plus the fixed building pressurization airflow *Vbp* (refer to Paragraph M) :

$$MinOAsp = \text{MAX}\ (\ \text{MIN}\ (\ (Vou\ /\ Ev)\ |\ DesVot\ )\ |\ (Vex + Vbp)\ )$$

i. Minimum outdoor air setpoint for AHUs in a manifolded system shall be portioned equally between all operating air handling units.

O. Smoke Control:

1. Refer to Smoke/Fire Alarm Mode.

P. Increased Ventilation (Contaminant Purge) Mode Operation:

1. System shall permit AHU to enter into Increased Ventilation mode upon manual override from the BAS operator interface.
2. Upon selection of Increased Ventilation mode, interface shall require operator to designate duration (in hours) of Increased Ventilation operation. Duration shall be limited to a maximum of 24 hours (FA) to prevent mode from continuing without regular operator engagement.
3. A Level 3 alarm shall be signaled upon activation of Increased Ventilation mode.
4. During Increased Ventilation mode, the unit supply fans, return fans, and relief damper shall operate as normal in occupied mode. The outside air damper shall remain fully open. The return air damper, heating, and cooling control valves shall be sequenced as follows:

   a. Return air damper shall fully close.
   b. Heating and cooling coil control valves shall modulate as in normal operation to maintain the unit discharge air temperature setpoint.
   c. If heating or coiling coil control valve is greater than 95% open (FA) and unit discharge air temperature setpoint cannot be maintained within a +/- 2°F (FA) deadband for 5 minutes (FA):

      1) The active control valve (i.e. CHW valve when discharge air temperature is above setpoint, HW valve when discharge air temperature is below setpoint) shall be locked in 100%(FA) open position, with the inactive valve locked in fully closed position.
      2) The return air damper shall open and be modulated to maintain mixed air temperature at setpoint of 3°F (FA) below unit discharge setpoint.
      3) If the return air damper remains less than 5% (FA) open for 5 minutes (FA), the return damper shall fully close and coil control valves shall unlock and return to normal operation to maintain discharge air temperature setpoint.

5. All safeties and alarms shall operate as normal.

Q. Miscellaneous:

1. Provide safety low limit control at entering side of cooling coil. It shall de-energize unit supply fans, close minimum and maximum outside air dampers and relief damper, open return air damper, open preheat and cooling coil control valve when air temperature falls below 38°F. A Level 2 alarm shall be signaled through the BAS whenever the safety low limit control is activated.
2. Provide high static pressure limit control with sensor located in supply fan discharge to override fan volume control when pressure reaches +3.5” wg (FA) and modulate supply fans to maintain discharge pressure of 3.0” wg (FA).
3. The BAS shall continuously monitor and compare pressure signals from each static pressure sensor / transmitter. Whenever system duct pressure as sensed by pressure sensors has deviation of more than 20% (FA) from setpoint, a Level 2 alarm shall be indicated at the BAS. Whenever output from any pressure sensor / transmitter drops below 10% (FA) or rises above 90%(FA) of calibrated range, that pressure sensor / transmitter shall be removed from active control and an alarm indicated at the BAS. The remaining static pressure sensors/transmitters shall be utilized for

active control. The inactive pressure sensor shall remain inactive until manually reset through the BAS.

4. Building pressurization shall be continuously monitored through differential pressure transmitters mounted as shown on plans to continuously measure differential pressure of the space relative to the outdoors. The intent is to maintain the building at a slight positive pressure (+0.01" wg to +0.05" wg) at all times through the control of air handling unit outside, return and relief air dampers. Differential pressure shall be continuously monitored and trended and shall provide a Level 2 alarm through the BAS if building differential pressure drops to -0.03" wg (FA) or rises above +0.10" wg(FA). Whenever there is a deviation of more than 50%(FA) between building differential pressure transmitters, a Level 2 alarm shall be signaled through the BAS.
5. Smoke / isolation dampers shall be electrically interlocked with the fans so that the dampers begin to open at same time that unit supply fans are signaled to start and shall close when unit is de-energized. If dampers are not proven fully open by respective limit switches on dampers within 20 seconds (FA), of fan start command, supply fans shall be de-energized and a Level 2 alarm shall be generated at the BAS. Smoke/isolation damper opening and closing speed shall be adjustable so that damper closes a few seconds before fan stops to prevent overpressure of system.
6. Return Low Pressure Safety: Provide low static pressure limit control with sensor located in return fan intake plenum to override return fan volume control when pressure reaches -2.5" wg (FA) and modulate return fans to maintain discharge pressure of -2.0" wg (FA).
7. Mixed Air Low Pressure Safety: Upon activation of a low static pressure safety limit control set at -0.6" wg (FA) and mounted in the mixed air plenum of the AH, the return air damper controls for the unit shall be overridden and the return damper shall modulate open to maintain mixed air pressure setpoint of -0.5" wg (FA). Whenever the low-pressure safety is activated, a Level 2 alarm shall be generated at the BAS.

3.14 AIR HANDLING UNIT (AHU-3, 4) - CONTROL SEQUENCE

A. General:

1. System is designed as cooling and heating, single duct, variable volume reheat system with humidity control for the Special Collections archive.
2. System fans consist of packaged air handling unit with two (2) supply fans. Each fan is provided with EC motor.
3. AHU-3 and AHU-4 are ducted in parallel with each sized for 100% of the Special Collections heating, cooling, and dehumidification load. The units operate in a lead-standby arrangement.
4. AHU-3 and AHU-4 along with all associated equipment (air terminals, steam generator) are connected to emergency generator power.
5. Ventilation and pressurization air is provided by an air terminal box connected to the building's primary air supply system (AT-SA2103; AHU-1,2). Pressurization relief is provided by an air terminal box connected to the building's primary air return system (AT-RA2103; AHU-1,2).
6. System is designed for minimum and maximum ventilation air based on occupancy control as sensed by the occupancy sensors located throughout the Special Collections archive space.
7. Temperature and humidity setpoints within the Special Collections archive shall remain constant and shall never be reset based on occupancy, ambient conditions, or any other scenarios.

B. Unit Operating Mode:

1. System shall operate all the time with a single operating mode.
2. BAS shall program time initiated functions and other items as specified.
3. Control Contractor shall provide all necessary devices such as relays required for interface.
4. System is also provided with Smoke / Fire Alarm Shutdown Mode as outlined in separate section.

C. Unit Operation:

1. Unit operation shall be automatic and activated through the building automation system.

2. Air handling units AHU-3 and AHU-4 shall be started and stopped automatically through the BAS. The unit with the lowest run hours shall be selected as the lead AHU, the unit with the most hours will be selected as the standby AHU. Each week (FA), the BAS will reselect the lead / standby units to balance run hours. The lead / standby sequence will remain for the entire week.
3. Current sensing shall be used to prove fan operation. Failure of one or more supply or return fans shall result in a critical (Level 2) alarm activated through the BAS.
4. If supply fans are signaled to start and any fan does not start within 20 seconds (FA) of start command, or if operating fan(s) fails based on motor current switch, the unit with the failed fan(s) shall be rotated to standby and de-energized, a critical (Level 2) alarm shall be generated through the BAS, and the next AHU shall be energized after at 30 second (FA) delay. The failed unit shall remain locked out until manually reset through the BAS.
5. If any of the supply fans in the air handling unit fail to operate when commanded to start, the supply isolation damper and return air damper for the unit shall close in addition to requirements specified above.

D. Interlocking:

1. Interlock smoke/isolation dampers on unit discharge and entry with supply fans so that dampers are proven open by limit switch prior to fan start signal.
2. Interlock associated humidifier(s) so that humidifier(s) will be inoperative when the following conditions occur.

   a. No unit supply fan is operating.
   b. Unit is operating in dehumidification mode (relative humidity exceeds 50% (FA) in any zone).

E. Occupied and Unoccupied Operation:

1. System does not require setpoint occupied-unoccupied operation. System shall operate continuously with primary air ventilation/pressurization.
2. The flow sensor / transmitter in the primary air terminal box shall provide continuous measurement of ventilation/pressurization air through the BAS. A low flow (Level 2) alarm shall be signaled through the BAS whenever primary air drops below minimum scheduled amount for 15 minutes (FA).

F. System Air Volume Control:

1. System volume control will be accomplished by electrically commutated motors (ECM).
2. Arrange controls so that fans shall always start at low speed. Control system shall be configured so that all fans in a unit operate at the same speed based on static pressure signals defined below. On failure of a fan, the unit shall be rotated to standby and de-energized as described in Unit Operation above.
3. Fan speed for all fans in unit shall be modulated in parallel from common static pressure signal. Duct static pressure shall be measured with pressure transmitters located in supply duct as shown on plans. On a drop in static pressure below setpoint, as measured by any of the respective pressure sensors/transmitters associated with the air handling unit, the speed of all operating supply fans shall increase simultaneously and in parallel until static pressure setpoint has been satisfied at all pressure sensing locations associated with that system. On rise in static pressure above setpoint of all system static pressure sensors for the air handling system, the speed of all operating supply fans shall decrease simultaneously and in parallel until the setpoint of any one pressure sensor/transmitter associated with the system is satisfied. Static pressure setpoint shall be modified automatically through the BAS based on VAV box damper position. The BAS shall monitor all terminal box damper positions every 10 minutes (FA) and update static pressure setpoint.
4. Provide appropriate electrical signal input to volume control devices and necessary devices such as a transducer.

5. Control Contractor shall work in association with Test and Balance Contractor to determine actual required static pressure setpoints. Actual static pressure setpoints shall be minimum pressure required to achieve design airflow.
6. Locate static pressure sensors in supply duct near the end of the system as shown on plans. Initial setpoint for static pressure transmitters shall be 1.5" wg (FA) and shall be coordinated during TAB work to be the lowest setpoint required to achieve design flow to all air terminals on the system with any one air terminal damper operating at 95% open with all spaces balanced to maximum scheduled flow rates.

G. Unit Discharge Air Temperature Control:

1. Unit controller shall modulate DX cooling coil, hot gas reheat coil, and associated condensing units (CU) to maintain unit cooling coil and discharge air temperature setpoints. Unit controller shall operate refrigeration system components with manufacturer-specified runtimes to protect equipment and promote efficient operation.
2. Unit discharge temperature setpoing shall be reset from a high of 65°F(FA) to a low of 55°F (FA) based on maintaining space temperature in all zones. Discharge air temperature setpoint shall drop in 1°F (FA) increments whenever any air terminal is in cooing mode with damper position greater than 90%(FA) open for 5 minutes (FA). Discharge air temperature shall rise in 1°F (FA) increments whenever 80% (FA) of air terminal electric reheat coils are energized for 5 minutes (FA).
3. Dehumidification Mode:

   a. Maximum sensed relative humidity of all zone sensors and return air sensor shall be continuously calculated and provided as input to unit controller as Control RH. If Control RH exceeds 50% (FA) for 5 minutes (FA), unit shall enter Dehumidification Mode:

      1) Unit cooling cool temperature shall be reset downward to maintain maximum 50%.
      2) Modulating hot gas reheat coil shall operate to maintain unit discharge air temperature as determined by zone space temperature as described above.
      3) Steam generator and humidifier will be de-energized and prevented from operating.

   b. Once Control RH has reached 50%(FA) or less for 5 minutes (FA), unit shall end Dehumidification Mode and return to normal operation by modulating cooling coil to maintain unit discharge air temperature as determined by space temperature as described above.

H. Smoke Control:

1. Refer to Smoke/Fire Alarm Mode.

I. Miscellaneous:

1. Provide high static pressure limit control with sensor located in supply fan discharge to override fan volume control when pressure reaches +3.5" wg (FA) and modulate supply fans to maintain discharge pressure of 3.0" wg (FA).
2. The BAS shall continuously monitor and compare pressure signals from each static pressure sensor / transmitter. Whenever system duct pressure as sensed by pressure sensors has deviation of more than 20% (FA) from setpoint, a Level 2 alarm shall be indicated at the BAS. Whenever output from any pressure sensor / transmitter drops below 10% (FA) or rises above 90%(FA) of calibrated range, that pressure sensor / transmitter shall be removed from active control and an alarm indicated at the BAS. The remaining static pressure sensors/transmitters shall be utilized for active control. The inactive pressure sensor shall remain inactive until manually reset through the BAS.
3. Pressurization within the Special Collections archive shall be continuously monitored through differential pressure transmitters mounted as shown on plans to continuously measure differential pressure of the space relative to the adjacent Special Collections Reading Room and Special Collections Office. The intent is to maintain the archive at a slight positive pressure (+0.01" wg to

+0.05" wg) at all times through the control of ventilation/pressurization and relief air terminal boxes AT-SA2103 and AT-RA2103. Differential pressure shall be continuously monitored and trended and shall provide a Level 2 alarm through the BAS if archive differential pressure drops to -0.03" wg (FA) or rises above +0.10" wg (FA). Whenever there is a deviation of more than 50%(FA) between archive differential pressure transmitters, a Level 2 alarm shall be signaled through the BAS.

4. Smoke / isolation dampers shall be electrically interlocked with the fans so that the dampers begin to open at same time that unit supply fans are signaled to start and shall close when unit is de-energized. If dampers are not proven fully open by respective limit switches on dampers within 20 seconds (FA), of fan start command, supply fans shall be de-energized and a Level 2 alarm shall be generated at the BAS. Smoke/isolation damper opening and closing speed shall be adjustable so that damper closes a few seconds before fan stops to prevent overpressure of system.
5. Return Low Pressure Safety: Provide low static pressure limit control with sensor located in return fan intake plenum to override return fan volume control when pressure reaches -2.5" wg (FA) and modulate return fans to maintain discharge pressure of -2.0" wg (FA).

3.15 STEAM GENERATOR AND HUMIDIFIER - CONTROL SEQUENCE

A. Control humidifier by humidistat acting through high limit humidity sensor. Locate high limit humidity sensor in supply duct at least 6 ft downstream of humidifier; set to de-energize humidifier whenever relative humidity exceeds 85% at 55°F.

B. Controlling humidity input shall be determined by the BAS as the minimum sensed relative humidity of all Special Collection zone humidity sensors and return air humidity sensor.

C. Controlling humidity setpoint shall be set at 45% relative humidity (FA) at 63°F.

D. De-energize humidifier when its associated supply fan is de-energized.

E. De-energize humidifier when AHU-3/4 is operating in Dehumidification Mode.

3.16 SMOKE/FIRE ALARM MODE - CONTROL SEQUENCE

A. Smoke Detectors in Ductwork at AHUs:

1. Smoke detectors will be furnished by Electrical Contractor, installed by Mechanical Contractor, and wired to Fire Alarm Control Panel by Electrical Contractor.
2. Wire auxiliary contact on smoke detector to air handling unit supply fan starter.
3. Air handling units (AHU-1 through 4) smoke detector(s) upon detection of smoke in unit shall stop its pair of air handling units, close smoke/isolation dampers at unit discharge and inlet, close minimum and maximum outside air dampers, and close return air damper. The unit shall be re-started manually through BAS.

B. Supply Air and Return Air Smoke Isolation Dampers at AHUs:

1. Smoke/isolation dampers installed exterior to AHUs will be furnished by Control Contractor, installed by Mechanical Contractor, and wired by Control Contractor. Smoke/isolation dampers installed within AHUs will be furnished with equipment and wired by Control Contractor.
2. On air handling unit start-up, all smoke dampers associated with the air handling system shall open and be proven open by limit switches before supply fan is allowed to operate.

3.17 EXHAUST FANS - CONTROL SEQUENCES

A. Exhaust Fan (EF-1) – Control Sequence

1. Exhaust fan EF-1 serves toilet and general exhaust.
2. Exhaust fan hall be started and stopped automatically through the BAS and shall operate continuously.
3. Current sensing at each fan motor shall prove flow.
4. When fan is not operating, associated control damper shall be closed.
5. If fan does not start within 20 seconds (FA) of command to start or if operating fan fails as proven by current switch on fan motor, the failed fan shall be de-energized and a critical alarm shall be signaled at the BAS. Failed fan shall remain locked out until manually reset through the BAS.
6. System Volume Control:
    a. Exhaust fan is provided with electrically commutated (EC) motor for air volume control.
    b. Flow sensors mounted in the exhaust fan inlets shall provide continuous measurement of exhaust airflow.
    c. During Occupied Mode, exhaust fan shall be registered as occupied and speed controller shall modulate to maintain the maximum airflow indicated on the fan schedule.
    d. During Unoccupied Mode, exhaust fan shall be registered as unoccupied and speed controller shall modulate minimum airflow indicated on the fan schedule.
7. Flow sensors mounted in the exhaust fan inlets shall provide continuous measurement of exhaust airflow.

B. Exhaust Fan (EF-2) – Control Sequence

1. Exhaust fans EF-2 serves the Makerspace.
2. Exhaust fan hall be started and stopped automatically through the BAS and shall operate continuously.
3. Current sensing at each fan motor shall prove flow.
4. When fan is not operating, associated control damper shall be closed.
5. If fan does not start within 20 seconds (FA) of command to start or if operating fan fails as proven by current switch on fan motor, the failed fan shall be de-energized and a critical alarm shall be signaled at the BAS. Failed fan shall remain locked out until manually reset through the BAS.
6. System Volume Control:
    a. Exhaust fan is provided with electrically commutated (EC) motor for air volume control.
    b. Flow sensors mounted in the exhaust fan inlets shall provide continuous measurement of exhaust airflow.
    c. During Occupied Mode, exhaust fan shall be registered as occupied and speed controller shall modulate to maintain maximum scheduled value as measured by the airflow measuring sensor.
    d. During Occupied-Standby and Unoccupied Mode, exhaust fan shall be registered as unoccupied and speed controller shall modulate to maintain minimum schedule value as measured by the airflow measuring sensor. (FA)
    e. Occupancy Sensor timer to initiate Occupied-Standby and Unoccupied mode for the Makerspace shall be 30 minutes (FA).

3.18 ALTERNATE 16B: CONDENSATE RECLAIM WATER SYSTEM – CONTROL SEQUENCES

1. Sump Pump (P-RCW-1)

   a. Sump pump controller shall be provided with 3 UL Listed mechanical float switches (Pump on, Pump Off, High water level) mounted to vertical float tree:

      1) Pump on installed at 80% tank capacity.
      2) Pump off installed at 10% tank capacity (or as required by sump pump).
      3) High water level installed at 90% tank capacity.

   b. Controller shall start and stop pump based on float switch input and notify BAS of command signal.
   c. A high pressure switch located in the discharge piping shall override pump operation and de-energize pump if pressure reaches 16 psig (FA) for 1 minute and generate a Level 2 alarm.
   d. Current sensing at pump motor shall be used to prove flow.
   e. If pump does not start within 20 seconds (FA) of command to start as proven by current switch on fan motor, a Level 2 alarm shall be signaled at the BAS.
   f. If pump does not stop within 20 seconds (FA) of command to stop as proven by current switch on fan motor, a Level 2 alarm shall be signaled at the BAS.
   g. Activation of the high water alarm shall generate Level 2 alarm at BAS.

2. Flow Monitoring

   a. The BAS will record and trend the reclaim water flow in GPM and Gallons to capture the daily, monthy, and annual water returned to the energy plant.

END OF SECTION 230993

SECTION 232116 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes pipe and pipe fitting specifications and installation requirements for heating and cooling systems.

1.2 ACTION SUBMITTALS

A. Shop drawings for each piping system for all pipe sizes including, but not limited to, the following:

1. Name of system
2. Pipe; ASTM number, grade if known, type, wall thickness, material
3. Fittings; ASME number, grade if known, class, type, wall thickness, material
4. Joint type
5. Flanges; ASTM number, grade, class, type, material
6. Bolts and nuts; material
7. Thread joint sealants; material
8. Flange gaskets; material, rating
9. Unions; ASTM number, type, material, rating
10. Test pressure and media
11. Pipe flushing procedures
12. Pipe cleaning method
13. All other appropriate data

B. Product data sheets for all information requested above and provide a schedule listing each piping system and applicable data (i.e., pipe size limits, pipe construction, fitting type, union/flange ratings, etc.) for each system.

1.3 INFORMATIONAL SUBMITTALS

A. Pipe certification as specified under Pipe Certification in this Section.

B. Piping Pressure Testing planning report.

C. Flushing and Cleaning Piping systems planning report.

D. Submit Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work to Designer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1 and B31.9, as applicable.

E. Submit written quality control program for review and approval prior to implementing any welding on this project.

1.4 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish a small socket fusion equipment machine capable of making ½” to 2” PP-R / PP-RCT joints.

B. Furnish a large socket fusion equipment machine capable of making 2 ½: to 5” PP-R / PP-RCT joints.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.

B. Where possible, store materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.6 PIPE WELDING

A. Procedure and Welding Qualification Records:

1. Perform all welding in accordance with the North Carolina Boiler Rules.
2. Unless otherwise indicated, welding shall be done using only the following processes:
3. Shielded Metal Arc Welding (SMAW), also known as "stick" welding
4. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding
5. Submerged Arc Welding (SAW)
6. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with ASME B31.1 or B31.9, as applicable.
7. Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Designer.

B. Quality Control Program:

1. Quality control program shall include the following as minimum:

a. Explanation of how Contractor will assure proper fitup for each weld.
b. Explanation of how Contractor will document welds performed by individual welding operators for systems under ASME B31.1.
c. Explanation of how Contractor will assure that proper welding procedure is being followed.
d. Credentials of personnel responsible for required weld examinations.

C. Weld Inspection and Examination:

1. Provide examination services for all welding for this project. Examination shall be in accordance with requirements of ASME B31.1, Table 136.4 or B31.9, as applicable. Personnel performing examinations shall comply with requirements stipulated in 136.1 (A) through (E) or shall be AWS QC1 certified.
2. Periodically, as welding progresses, submit report, signed by weld examiner, indicating status of project welding quality.
3. Arrange with Owner's Inspector for observation of fitup and welding methods prior to implementing any welds, including shop welds, on this project.
4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

D. Welder Qualifications:

1. Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.
2. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.
3. Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.
4. Record of welding continuity shall include, at minimum, the following:

   a. Welder's employer name and address
   b. Date Welder Qualification Test was passed
   c. Dates indicating welding continuity

5. Welders shall be qualified as required by ASME B31.1 or B31.9, as applicable. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Designer's Inspector or consultant approved by National Certified Pipe Welding Bureau.
6. Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in "6G position."

E. Weld Record:

1. For welding within the scope of ASME B31.1 Power Piping, submit to Designer for approval an administrative procedure for recording, locating, monitoring and maintaining quality of welds to be performed on the project. This quality control document record shall include but not be limited to:

   a. Drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date, and WPS used.

1.7 PLASTIC PIPE JOINT BONDING

A. Procedure and Bonding Qualification Records:

1. All Bonding Procedure Specifications (BPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work shall be submitted to Engineer for review and approval prior to performing any bonding. These documents shall meet requirements of ASME B31.1.
2. Unless otherwise indicated, bonding shall be done using only the following processes in accordance with ASTM D2657, and pipe manufacturer’s recommendations:

   a. Technique I - Socket Fusion
   b. Technique II - Butt Fusion
   c. Technique III - Saddle Fusion
   d. Technique IV - Electrofusion

3. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with B31.1.

B. Quality Control Program:

1. Submit written quality control program for review and approval prior to implementing any bonding on this project. Quality control program shall include the following as minimum:

   a. Explanation of how Contractor will assure proper fitup for each bonded joint.

b. Explanation of how Contractor will document bonds (joints) performed by individual bonding operators for systems under ASME B31.1.
c. Explanation of how Contractor will assure that proper bonding procedure is being followed.
d. Credentials of personnel responsible for required bonded joint examinations.

C. Bond (Joint) Inspection and Examination:

1. Provide examination services for all bonding for this project. Examination shall be in accordance with requirements of ASME B31.1-2014, Section N-136, as applicable. Personnel performing examination shall comply with requirements stipulated in N-136.2 (A) through (E).
2. Periodically, as bonding progresses, Contractor shall submit report, signed by examiner, indicating status of project bonding quality.
3. Arrange with Owner's Inspector for observation of fitup and bonding methods prior to implementing any bonds, including shop bonds, on this Project.
4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper bonding is provided. Owner reserves the right to perform independent examination of bonds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress bonding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

D. Bonder Qualifications:

1. Each bonder and bonding operator must qualify by passing required procedure test before performing any project bonds (joints). Submit copy of Manufacturer's Record of Bonder or Bonding Operator Qualification Tests as required by Section N-127.5 of ASME B31.1-2014 for all bonding procedures to be performed by bonding operator.
2. Qualifications in one Bonding Procedure Specification (BPS) does not qualify a bonder or bonding operator for any other bonding procedure.
3. Bonder qualifications must be current. If qualification test is more than 6 months old, provide record of bonding continuity for each bonder.
4. Record of bonding continuity is intended to show that bonder has performed bonding at least every 6 months since the date that bonder qualification test was passed for the submitted welding procedure specification.
5. Record of bonding continuity shall include, at minimum, the following:

   a. Bonder's employer name and address.
   b. Date Bonder Qualification Test was passed.
   c. Dates indicating bonding continuity.

6. Bonders shall be qualified as required by ASME B31.1. In addition, there shall be an independent witness of bonder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by piping manufacturer.
7. Bonder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in"6G position".

E. Bond Record:

1. For bonding within the scope of ASME B31.1 Power Piping, submit to Engineer for approval an administrative procedure for recording, locating, monitoring and maintaining quality of bonds to be performed on the project. This quality control document record shall include but not be limited to:

   a. Drawings and schedules identifying location of each bond by individual number, identification of bonder who performed each bond by individual bonder's name, stamp number, date, and BPS used.

1.8 PIPE CERTIFICATION

A. Certification is required for all pipe within scope of ASME B31.1 and steel piping for water systems outlined below. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

B. All pipes shall be domestically produced, as evidenced by the required Mill Certification.

C. Type E or S Pipe:

1. Furnish manufacturer's mill certificates (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

PART 2 - PRODUCTS

2.1 GENERAL

A. Use only new material, free of defects, rust and scale, and guarantee for services intended.

B. Use material meeting the latest revision of ASTM specifications as listed in this specification.

C. Follow local codes if they require other types of pipe or joints.

D. For butt welded pipe, use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.

E. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

F. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

G. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.

H. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:

1. B31.9 Building Services Piping (Chilled Water and Hot Water Piping)

2.2 CHILLED WATER & HEATING HOT WATER

A. Use metallic piping in lieu of polypropylene pressure piping only at the following locations:

1. Where necessary for connections to equipment and valves.
2. Supporting in-line pumps.

B. Metallic Piping:

1. 2" and Smaller:

a. Pipe: ASTM B88 seamless, Type L, hard temper copper tube.
b. Fittings: ASME B16.22, wrought copper solder joint.

c. Joint: ASTM B32, lead free solder, Bridgit, Silvabrite, Silverflow or Canfield.
d. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4" and smaller. Unions shall be used for line sizes over 1".
e. Flanges: ASME B16.24, Class 150, cast copper alloy.
f. Use solder joints for valves and piping specialties in copper piping.

2. 2-1/2" and Larger:

a. Pipe: ASTM A53, Grade B, Type E or S, standard weight, carbon steel.
b. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld.
c. Flanges: Class 150. Refer to Unions and Flanges in this Section.

C. Polypropylene Pressure Piping (all sizes):

1. Pipe: Polypropylene pressure piping, PP-R or PP-RCT

a. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
b. All pipe shall be made in a three layer extrusion process with a fiberglass filled layer to restrict thermal expansion.
c. All pipe shall be certified by ICC-ES as complying with the rated pressure and other requirements of ASTM F 2389 and CSA B137.11.

2. Pipe shall be installed based on system pressure and temperature. The pipe Standard Diameter Ratio (SDR) (SDR: Ratio between the wall thickness and outside diameter) shall be as follows:

	Pipe Size	Chilled Water	Heating Hot Water
a.	3/4"	SDR 7.4	SDR 7.4
b.	1" to 4"	SDR 11	SDR 9
c.	6" and greater	SDR 17.6	SDR 9

3. Where piping is manufactured in metric outside diameter (OD) dimensions, the corresponding imperial nominal diameter (ND) shall be as follows:

ND	OD		ND	OD
3/4"	25 mm		3"	90 mm
1"	32 mm		3-1/2"	110 mm
1-1/4"	40 mm		4"	125 mm
1-1/2"	50 mm		6"	160 mm
2"	63 mm		8"	200 mm
2-1/2"	75 mm		10"	250 mm

4. Where insulation is not specified in Division 23 – Mechanical Systems Insulation, the pipe shall be wrapped such that the pipe/wrap assembly meets the requirements of ASTM E84 with a Flame Spread Classification of less than 25 and a Smoke Development rating of less than 50.
5. Fittings: PP-R / PP-RCT, ASTM F2389

a. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
b. All fittings shall be certified by ICC-ES as complying with the rated pressure and other requirements of ASTM F 2389 and CSA B137.11.

6. Joint: Socket-fusion, electrofusion or butt-fusion as applicable for the fitting or joint type and prepared in accordance with ASTM F 2389.

2.3 REFRIGERANT PIPING

A. ASTM B88 Type L hard drawn copper tube, cleaned and capped in accordance with ASTM B280, and marked "ACR" with ANSI B16.22 wrought copper or forged brass solder-type fittings.

2.4 COOLING COIL CONDENSATE DRAIN

A. Piping shall be any of the following options:

1. Copper

a. Pipe: ASTM B88, Type M, hard temper copper tubing
b. Fittings: ASTM B16.22 wrought copper fittings
c. Joint: ASTM B32, 95-5 tin-antimony solder, Bridgit or Silvabrite

2. PVC

a. Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC)
b. Fittings: ASTM D2665, solvent weld PVC fittings

2.5 HUMIDIFICATION STEAM AND CONDENSATE (ULTRA-LOW PRESSURE, THROUGH 2 PSIG)

A. General:

1. Ultra-Low-Pressure humidification steam is steam generated by local humidification-specific steam generator, which produce very low pressure steam delivered to dispersion manifolds, typically at less than 2 psig.
2. Provide Steam Generator manufacturer's hose connections for steam distribution and condensate when distances and application are within manufacturer's recommended limits. Otherwise, provide tubing as listed below.

B. 2" and Smaller:

1. Pipe: ASTM A312 TP304 or TP304-L, Schedule 10S or 40S
2. Fittings: ASTM A403, WP 304 or 304L, ASME B16.11, 3000 lb socket-weld
3. Unions: ASME B16.39, black malleable iron ground joint, bronze or brass to iron, Class 250
4. Flanges: Class 150, ASTM A182, Grade F 304 or 304L, ASME B16.5 or ASME B16.47 Series A or B, welding neck

C. 2-1/2" and Larger:

1. Pipe ASTM A312, Type 304 or 304L, stainless steel, Schedule 10S 40S
2. Fittings: ASTM A403 Grade WP304 WP304-L, Class S or Class W, ASME 16.9
3. Flanges: Class 150, ASTM A182 Grade F304 F304-L, ASME B16.5 or ASME B16.47 Series A or B, welding neck

D. Bolts and Nuts:

1. ASTM A193, Grade B8 Class 1 or Class 2 with nuts conforming to ASTM A194, Grade 8 and washers conforming to ASTM A240 TP304.

E. Gaskets:

1. ASME B16.21 and ASTM F104 flat ring type, asbestos-free, compressed inorganic fiber with nitrile binder.

2. 2-1/2” thru 6”

   a. Gasket thickness 1/16”
   b. Maximum Seating Stress (y) 2600 psi
   c. Minimum Gasket Factor (m) 6.6

3. Garlock, Klingersil or J.M. Clipper, similar to Garlock 5500.

2.6 NON-POTABLE COLD WATER MAKE-UP

A. Refer to Section 22 1118 - Water Distribution System.

2.7 CHEMICAL TREATMENT

A. Closed Water System (Chilled Water, Hot Water):

1. Use pipe and fittings as indicated for the system to which chemical treatment piping is connected.

2.8 VENTS AND RELIEF VALVES

A. Use pipe and pipe fittings as indicated for the system to which relief valve or vent is connected.

2.9 PRESSURE GAUGES AND TAPPINGS

A. Use pipe and pipe fittings as indicated for the system to which pressure gauge or tapping is connected. Use "Threadolets", "Sockolets" or tee fittings for tappings. Refer to Part 3 under General for use of "Threadolets" and "Sockolets".

B. Gauge pipe shall be 1/4" Schedule 80 unless otherwise indicated.

2.10 DIELECTRIC UNIONS, FLANGES AND FITTINGS

A. Copper to Steel Pipe:

1. 1" and Smaller: ASTM A197/ASME B16.3, 300 lb, WOG malleable insulating unions with vulcanized fiber insulating sleeve and neoprene gasket, equal to Stockham figure 693-1/2, or Epco model FX or FB dielectric unions with dielectric gasket, 250 psi at 210°F.
2. 1-1/2" and Larger: Epco model GX dielectric flange for 1-1/2" and 2" and model GWX for 2-1/2" and larger with dielectric gasket, 175 psi at 210°F.

B. Clear Flow dielectric fittings may be used in lieu of dielectric unions for pipe sizes 2" and smaller.

C. Clear Flow fittings shall be ASTM A120/A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig.

D. Steel to Steel Pipe:

1. 1" and Smaller: Similar to Epco model HA-B with dielectric gasket, 250 psi at 210°F.
2. 1-1/2" and Larger: Similar to Epco model W with bolt insulators, dielectric gasket, bolts and nuts, 175 psi at 210°F. Pikotek model VSC dielectric gasket with viton sealing element, G-10 sleeve and double washers, suitable to 350°F, may be used with specified flanges.

E. Plastic-to-Metal Transition fittings:

1. Flange adapters with fusible adapter fitting of same material as piping, and ANSI bolt pattern. Bolt ring material shall be polymer or epoxy coated steel as recommended by polymer piping manufacturer. Flange adapters shall be thermally bonded to pipe as specified by polymer piping manufacturer.
2. Threaded adapters shall not be used unless approved by engineer.

2.11 UNIONS AND FLANGES

A. Unions:

1. 2" and Smaller: Forged steel, ASTM A105 Grade 2, ASME B16.11, socket weld, 3000lb. WOG with steel to steel seats.

B. Flanges:

1. 2-1/2" and Larger: ASTM A105, ASME B16.5, hot forged steel, welding neck pattern. Slip-on pattern are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe.
2. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.
3. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of connected device, such as valves and piping specialties.

C. Flange Gaskets:

1. Gasket material shall be asbestos free and suitable for pressures, temperatures and fluid of respective piping system. Non-metallic gaskets shall be in accordance with ASME B16.21 and ASTM F104. Unless otherwise indicated or recommended by manufacturer, gaskets shall be similar to Garlock IFG 5500 with 1/16" thick gasket.
2. Service Temperature (through 249°F) – Garlock, Klingersil or J.M. Clipper, similar to Garlock 5500. Gaskets similar to Garlock Style 3000 or red rubber may be used for hydronic piping.
3. Flange gaskets for HDPE to steel piping transitions for chilled water – Flexitallic, Garlock or Lamons equal to Garlock Multi-Swell Style 3760, 0.125” thickness or as recommended by manufacturer.
4. Unless otherwise indicated or recommended by manufacturer, gaskets shall be full face compressed inorganic fiber with nitrile binder 1/16" thick for flanges 12” and smaller and 1/8” thick for flanges 14” and larger.
5. Service Temperature (250°F thru 800°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

D. Bolting:

1. Bolts, bolt studs, nuts and washers shall have zinc plated finish.
2. Thread shall be in accordance with ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1-1/8" and larger in diameter shall be 8 pitch thread series.
3. Threaded rods are not allowed as fastening elements.
4. For Class 150 flanges at 400°F or lower temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A307.

2.12 THREADED JOINT SEALANTS

A. Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50 to 400°F and up to 10000 psi (liquids) and 2600 psi (gases), certified by UL, CSA, and NSF.

B. Teflon tapes are not allowed.

PART 3 - EXECUTION

3.1 GENERAL

A. Remove foreign materials before erection. Ream ends of piping to remove burrs.

B. Install piping parallel to building walls and ceilings and at such heights so as not to obstruct any portion of window, doorway, stairway, or passageway. Install piping to allow adequate service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical piping plumb. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.

C. Provide anchors, expansion joints, swing joints and expansion loops so that piping may expand and contract without damage to itself, equipment or building.

D. Mitered elbows, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.

E. Unless otherwise indicated, use fittings as specified in Part 2 of this Section for elbows, tees, reducers, etc.

F. "Weldolets" with outlet size 2-1/2" and larger are not allowed. "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for pressure gauges and tappings. Materials of "Threadolets" and "Sockolets" shall match material of piping.

G. Install drains throughout systems to permit complete drainage of entire system.

H. Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.

I. Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed. Provide reducing fittings for valves smaller than pipe size.

J. Make connections to all equipment where that equipment requires piping services indicated in this Section.

K. For piping within the scope of ASME B31.1 Power Piping, transfer piping material specification and "Heat Number" to each segment of pipe prior to cutting.

L. Piping that is visible from occupied “finished” spaces shall be painted per architect’s direction.

M. Contractor is responsible for providing all manual air vents at high points and drains at low points of system to allow for appropriate air venting and complete drainage of system. Contractor shall be responsible for bleeding & venting all entrained air from circulating water systems prior to handing the systems over to the TAB agency for waterside TAB fieldwork to begin.

3.2 THREADED PIPE JOINTS

A. Threads of pipe and fittings shall conform to ASME B1.20.1.

B. Cut threads so no more than 3 threads remain exposed after joint is made. Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.3 FLANGED JOINTS

A. Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.

B. Position gasket concentrically so compression is equally distributed over entire gasket surface.

C. Apply an anti-seize compound to the gaskets or flanges.

D. Lubricate bolts with anti-seize compound and run nuts down by hand.

E. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.

F. Re-torque bolts 12 to 24 hours after start-up.

3.4 POLYPROPYLENE PRESSURE PIPE JOINTS

A. All installers must be certified by a factory trained technician and carry a bonding card provided by the manufacturer.

B. Install listed pipe materials and joining methods below in the following applications:

1. Polypropylene (PP-R) piping in SDR 7.4, 11, or 17 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.

C. Fusion Joints

1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
3. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications. Pipes shall be cut true and plumb. Insure proper temperature, melting times, and joining pressure of the fusion equipment.
4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
5. All butt fusion joints shall have internal weld bead reamed and bead material removed from system, tagged to match the joint number from the shop drawing, and turned over to the Owner. Where internal weld beads cannot be removed, electro-fusion coupling joints shall be used. At contractor's option, one size larger piping may be used in lieu of bead reaming and electrofusion joints.

D. Saddle Joints

1. Saddle joints must be no closer than three pipes sizes between the main and the branch.

E. Hangers and Supports

1. Install hangers and supports at intervals specified in NC Mechanical Code and/or as recommended by pipe manufacturer and specified in Section 23 0528 - Mechanical Supporting Devices.
2. Support vertical piping at each floor and as specified in the NC Mechanical Code. Piping 2" or smaller shall be installed with mid-story guides.

3.5 COPPER PIPE JOINTS

A. Cutting of tubing shall not make tubing out of round. Ream cut tube ends to full inside diameter.

B. Remove slivers and burrs remaining from tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for specific piping service.

3.6 WELDED PIPE JOINTS

A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.

C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 60°F before welding.

D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.

E. Use weld material diameter as procedurally required for type and thickness of work being done.

F. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus 5 seconds. Maintain purge for at least 2 layers of weld material.

G. Properly store welding materials.

H. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.

I. Weld reinforcement shall not exceed limits established in Chapter V of ASME B31.1.

J. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.

K. For piping within scope of ASME B31.1, each weld shall be permanently marked by welder performing weld. Each welder shall sign and date field welding log record for all welds performed by welder as indicated in Part 1.

3.7 WATER SYSTEMS

A. Pitch horizontal mains up at 1" per 40 ft in direction of flow. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

B. Main branches and runouts to terminal equipment may be made at top, side, or bottom 45° of main provided drain valves are suitably located for complete system drainage and manual air vents are located as described above.

C. Unless otherwise indicated, for upfeed risers, use top or top 45° connection to main and for downfeed risers use side or bottom 45° connection to main. If side or bottom 45° connection is not practical and bottom connection to main must be used, provide line size Y strainer with shut-off valve at each side at branch connection.

D. Use minimum of 3 elbows in each pipe line to terminal equipment to provide flexibility for expansion and contraction of piping systems. Offset pipe connections at equipment to allow for service such as removal of terminal equipment. Do not route piping through unobstructed clearance area required adjacent to air terminal controllers.

E. Use eccentric fittings for changes in pipe sizes and for valves smaller than pipe sizes, in horizontal lines, with fittings installed for proper air venting (top of pipe straight). Concentric fittings may be used for changes in pipe sizes and for valves smaller than pipe sizes in vertical lines.

F. Where mechanically formed tee fittings are allowed, form mechanically extracted collars in continuous operation, consisting of drilling pilot hole and drawing out tube surface to form collar having height of not less than 3 times thickness of tube wall. Collaring device to be adjustable.

G. Notch and dimple branch tubes. Braze joints. Apply heat properly so that pipe and tee do not distort. Remove distorted connections.

3.8 COOLING COIL CONDENSATE DRAIN

A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

B. Pitch pipe down at 1/4" per one foot for proper drainage.

C. Where copper piping is allowed, joints and fittings may be secured with 95-5 tin-antimony solder or brazing alloys.

3.9 REFRIGERANT PIPING

A. Solder joints shall be ASTM Grade 4 or 5 and have melting point of approximately 1250°F. Solder impurities shall not exceed 0.15%. Tubing shall be new and delivered to job site with original mill end caps in place. Clean and polish joints before soldering. Avoid prolonged heating and burning during soldering. Purge pipes with nitrogen during soldering. Provide manual shut-off and check valves as required.

B. Leak test by charging system to pressure of 10 psig with the same type of refrigerant that will be used in the system.

C. Charge refrigerant into system through Sporlan catchall filter-drier. Finally increase pressure to 300 psig with oil pumped dry nitrogen. Rap joints with rubber or rawhide mallet and check for leaks with electric leak detector having certified sensitivity of at least one ounce per year. Seal any leaks that may be found and retest.

D. After completion of leak test, evacuate system with vacuum pump to 2.5 mm Hg absolute as measured on accurate gauge.

E. System ambient temperature shall be above 60°F during evacuation, charge refrigerant into system to 0 psig, then repeat evacuation to 2.5 mm Hg absolute. Allow system to stand evacuated for at least 12 h. If no noticeable rise in pressure occurs, system may be charged.

F. Charge system with new refrigerant through charging valve and filter-drier. Continue charging until bubbles disappear from liquid line sight glass while compressor is in operation.

G. Refrigeration piping must be installed by firms who are experienced in installation of such piping.

H. Provide refrigerant service valves with full port ball valves at each liquid and gas connection at branch circuit controller and fan coil units. Provide valve with flared connections equal to line size. Charging valve to be on fan coil side of piping.

3.10 HUMIDIFICATION STEAM AND CONDENSATE

A. Install humidification steam and condensate connections in accordance with Steam Generator manufacturer's recommendations.

3.11 NON-POTABLE COLD WATER MAKE-UP

A. Refer to Section 22 1118 - Section Water Distribution System.

B. Install piping where indicated, including valves, piping specialties and dielectric unions required for functional system.

C. Raw water make-up piping for this Section is defined as fill line containing pressure reducing valve for water systems.

3.12 CHEMICAL TREATMENT

A. Install piping as indicated on drawings, as detailed, and as recommended by supplier of chemical treatment equipment.

3.13 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on drawings, as detailed, and as specified for each specific valve or piping specialty item.

3.14 DIELECTRIC UNIONS AND FITTINGS

A. Install dielectric unions, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric unions may be used only where brass fittings or brass valves are impractical, however, in no case shall dielectric electric unions be used at terminal device connections.

B. Concealed dielectric unions and fittings are not allowed.

3.15 UNIONS AND FLANGES

A. Unions are not required on copper piping with soldered joints for 1/2" and 3/4" line sizes. Unions are required for line sizes 1" and larger.

B. Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.

C. Concealed unions or flanges are not allowed.

D. Install back to back weld neck flanges between isolation valves and HDPE/PPR flange adapters where butterfly valves connect to HDPE/PPR piping systems. Provide beveled flange adapters or spool pieces as required to accommodate complete valve actuation.

3.16 PIPING SYSTEM PRESSURE TESTS

A. Submit planning report to demonstrate proper procedures are being followed.

B. Planning report shall contain the following minimum requirements:

1. Written narrative of procedure to be used for each system.
2. Provide list of measuring instruments to conduct test. List shall include measurement range, pressure/temperature limits, date put into service and date of last calibration.
3. Test report forms for review.

C. Planning report shall be submitted to Designer minimum of 30 days prior to commencement of testing.

D. Coordinate pressure tests with Commissioning Agent, Designer and Owner at least 7 days in advance of test.

E. Contractor shall notify Designer of all tests to be performed.

F. Conduct pressure test prior to flushing and cleaning of piping systems.

G. Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed below.

H. Conduct hydrostatic (HYDRO) test with test medium of water unless otherwise indicated.

I. If leaks are found, repair with new materials and repeat test until leaks are eliminated; caulking will not be acceptable.

J. Contractor is responsible for any damage to other systems resulting from pipe leaks during pressure tests.

K. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

L. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 hrs plus such additional time as may be necessary to conduct examination for leakage. Contractor shall have conducted a preliminary pressure test prior to final acceptance test to locate and correct any pipe leaks.

M. No pressure drop shall occur during test period. Any pressure drop in during test period indicates leakage.

N. Provide pumps, appropriately scaled and calibrated gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been successfully completed.

O. For hydrostatic tests, remove air from piping being tested by means of air vents or loosening of flanges. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system, due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

P. Conduct pressure tests with parameters indicated below:

System	Minimum Test Pressure	Remarks
Chilled Water	100 psig	HYDRO
Heating Hot Water	100 psig	HYDRO

3.17 FLUSHING AND CLEANING PIPING SYSTEMS

A. Submit shop drawings and written procedures to the Designer for approval prior to the start of any cleaning or flushing work. Include diagrams and calculations showing how system will be segmented for flushing to meet minimum velocity requirements, chemical injection points, temporary drain points, temporary bypass piping, etc.

B. Flush all water systems thoroughly for 30 minutes or longer, as required to ensure removal of all dirt and foreign matter from piping system. Bypass all pumps and equipment with line size bypasses and remove all strainers from strainer bodies. Provide circulation by Contractor supplied portable pumping apparatus. Provide a temporary 1/8” mesh strainer with the portable pumping apparatus to allow for regular removal of circulating debris during the flushing and cleaning process.

C. Provide temporary line size piping or hose to bypass coils, control valves, heat exchangers, other factory cleaned equipment, and any component which may be damaged, unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place.

D. All in-line instruments and devices including flow meters, temp/pressure gauges, etc. shall be removed prior to flushing and replaced with spool pieces. After completion of the cleaning, reinstall all instruments. All branch supply and return piping to terminal heating/cooling devices shall be isolated during initial flush sequence to prevent larger debris from becoming lodged in the control valve orifices, etc. Following the initial system flush, a final flush through the branch piping shall occur.

E. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary line size piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers. Drain system. Monitor strainer loading at pumps during flushing and clean as necessary to maintain velocity in piping system.

F. Provide all water, power, chemicals, temporary piping and any other appurtenances necessary for flushing and cleaning procedures.

G. Cleaning of Chilled Water and Heating Hot Water systems:

1. Drain the system.
2. Fill the system with water, vent and add recommended amount of cleaner. The cleaner should be diluted by at least 3:1 ratio to prevent excessive attack on metal surfaces at the point of application. Do not allow any chemicals to come into contact with galvanized surfaces.

3. Circulate system for 24 hours at the flow rate recommended by the chemical manufacturer. The building pumps shall not be used. Isolate or remove the pump from the piping being cleaned. Ensure that the temporary 1/8" mesh strainer is in place before cleaning begins.
4. Drain the system and remove the temporary mesh strainer and debris.
5. Fill system with water, vent and circulate for one hour. Drain the system.
6. Remove the temporary piping and pump and install and align the building pumps if required.

3.18 INITIAL SYSTEM FILL AND VENT

A. Fill and vent systems with proper working fluids.

B. Use fluids chemically treated as specified in Section 23 2514 - Chemical Treatment Systems.

3.19 PIPING PAINTING

A. Exterior piping to be protected from weather and painted promptly to prevent corrosion.

3.20 CLOSETOUT ACTIVITIES

A. Provide services of PP-R / PP-RCT manufacturer's authorized service representative to instruct Owner's personnel on the use of joint socket fusion equipment. Instruction shall include (2) four hour training sessions training owner on how to make PP-R / PP-RCT joints and how to install a PP-R / PP-RCT piping system.

END OF SECTION 232116

SECTION 232118 - VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data for each system for all sizes including, but not limited to, the following:

1. Manufacturer's name
2. Type
3. Model number
4. Materials of construction
5. Temperature/pressure ratings
6. Manufacturer's data sheets clearly cross-referenced
7. All other appropriate data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Gate valves, globe valves, check valves, and drain valves: Crane, Nibco, Apollo, Velan, Stockham, Powell, Milwaukee, Hammond, or Grinnell equal to manufacturer's Figure number listed. Provide valves of same make for these services.

B. Other valves: acceptable manufacturers and Figure Number listed under each item.

2.2 WATER SYSTEM VALVES

A. General:

1. Valves shall have valve ends as specified below.
2. Valves in copper piping shall have solder ends.
3. Provide valve neck extensions with sufficient length to allow for insulation where insulation is specified.

B. Ball Valves:

1. 2" and Smaller: ASTM B584 bronze body, chrome plated bronze or chrome plated brass ball or stainless steel ball, full port, threaded ends, teflon seat rings, blowout-proof stem, two-piece construction, 600 psi WOG, 150 psi SWP, Apollo No. 77, Watts, Milwaukee, Hammond or Anvil.
2. 2-1/2" to 6”: A536 Ductile Iron or ASTM B216 WCB steel body, chrome plated bronze or chrome plated brass ball or stainless steel ball, full port, flanged ends, teflon seat rings, two-piece construction. ANSI Class 150. Provide gear actuator and hand wheel for ball valves 4” and larger. American, Watts, Milwaukee
3. Provide valve neck extensions with sufficient length to allow for insulation where insulation is specified.
4. Ball valves for use in chilled water system to be rated for 250 psig at 100 F.

C. Spring Loaded Check Valves:

1. 2" and Smaller: bronze or iron body, threaded, Class 125 (200 psi WOG), Nibco Figure T-480, Mueller Figure 303-AP or Metraflex No. 700.

2. 2-1/2" and Larger: cast iron body, wafer type, 316 stainless steel spring, aluminum bronze or carbon steel disc, Buna-N seat, Class 125 (200 psi WOG), Nibco Figure W-910, Milwaukee 1400, Metraflex No. 700, Stockham Figure WG-970, Mueller Sure Check Model No. 71, or Crane Duo-check II.
3. For valves 8” and larger, provide lifting lugs or threaded holes for lifting eye bolts.

D. Shut-Off Valves:

1. 2” and Smaller: ball valves as specified in this Section.
2. 2-1/2” and Larger: butterfly valves as specified in this Section.

E. Balancing Valves:

1. 2" and Smaller: calibrated balancing valves.
   a. Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV, Tour and Anderson TBV, NIBCO S 1709 or Nexus for 1/2" and 3/4", Armstrong ABV, Tour and Anderson STAD/STAS, NIBCO T or S 1710 or Nexus, over 3/4", or fixed orifice with ball valve type as manufactured by Accusetters (Flow Design Inc.), Presco, Gerand Griswold Controls or Taco. Bronze or brass body, threaded connections for steel pipe and soldered connections for copper pipe, 125 psig WP or 400 psi WOG at maximum temperature of 250°F. Furnish valve with quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.
   b. Valves shall measure down to 0.2 gpm with accuracy of ± 1%.
   c. Valves shall be leak-tight at full rated working pressure.
   d. Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.
2. 2-1/2" and Larger: Nexus, Armstrong Series CBV or Tour and Anderson STAF-SG/STAG, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi working pressure, 250°F operating temperature. Fixed orifice with ball valve type as manufactured by FDI, Presco , Griswold Controls or Gerand, Class 150 flange, 250 psi working pressure, 250°F operating temperature will be acceptable up to 4" size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in Section 232120 - Piping Specialties, under Flow Sensors and Meters between check valve and butterfly valve may be used when sizes for Armstrong or T/A valves are not available. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.
3. Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature, 300 psi working pressure. Meter accuracy shall be ± 2% full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.

F. Terminal Unit Valve Assembly

1. Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements above.
2. HCi, Nexus, Griswold, Hays, IMI Flow Design, or FDI are acceptable.
3. Inlet assembly: combination of isolation ball valve, strainer, union, and PT readout ports similar to HCi Terminator Y,
4. Outlet assembly: combination of isolation ball valve, union, PT readout ports, and venturi flow meter similar to HCi Terminator B.

G. Butterfly Valves:

1. 2-1/2" and Larger: cast iron or ductile iron body, stainless steel shaft, bronze disc, aluminum-bronze disc, cast or ductile iron disc with welded nickel edge disc, electroless nickel plated ductile iron disc, or Nylon coated ductile iron disc, upper thrust bearing, resilient seat, rated at minimum 175 psi CWP for sizes through 12" and 150 psi CWP for sizes 14" and larger, suitable for continuous operation at temperature up to 250°F with EPDM seats, compatible to ANSI B16.1 Class 125/150 flange standards, conforming to MSS-SP-67.
2. Dead end pressure rating to be minimum 150 psi with no downstream flange/piping attached.
3. For valves 5" and smaller, provide 10-position lever actuators with locking devices. For valves 6" and larger, provide rotary hand wheel operators with adjustable position stop and position indicators. Size hand wheel operators with no higher than 40 lb. rim pull at full valve pressure rating.
4. Valve necks shall be of sufficient length to allow for insulation where insulation is specified. Wheel shaft shall be sufficient length so wheel does not touch insulation.
5. Provide full lug type valves permitting removal of down stream piping while using valve for system shut-off.
6. Furnish valves shall be used for balancing with adjustable memory stops.
7. Manufacturers: DeZurik, Keystone, Nibco, Grinnell, Demco, Stockham, Hammond, Milwaukee, Watts, Bray, Norris, Kitz or Centerline.

H. Water Pressure Regulating Valves:

1. Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G.
2. Spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for maximum working pressure of 125 psig and maximum operating temperature of 160°F.

I. Lockshield Valves:

1. Ball valves as specified above with locking handles for padlocking in open or closed position.

J. Drain Valves:

1. Ball valve as specified above with hose thread adapter and cap. Provide 3/4" minimum drain valve for piping larger than 1/2", except strainer blowdown valves shall be blowdown connection size. Provide 1/2" drain valve for 1/2" piping.

2.3 LIQUID PRESSURE RELIEF VALVES

A. Manufacturers: Kunkle, Consolidated, Keckley, Fulflo, or Lonergan.

B. Bronze or carbon steel body with internal components compatible with fluid and temperature-pressure range involved. Pressure relief mechanism shall be direct pressure actuated and shall have proportional opening characteristic.

C. ASME stamp not required, but valve carrying ASME “UV” Stamp will be acceptable.

D. Liquid type, setpoint, overpressure, and capacity shall be as scheduled.

2.4 GAUGE VALVES

A. Unless otherwise indicated, gauge valves for steam, steam condensate and feedwater services shall be gate valves. Gauge valves for all other services shall be ball valves. Gauge valve size shall match gauge pipe size as specified in Division 23 Section Pipe and Pipe Fittings.

2.5 CHAIN WHEEL OPERATORS

A. Similar to Babbitt cast iron or ductile iron adjustable sprocket rims and chain guides. Use galvanized or brass chain and chain closure links to form continuous loop of chain at each operator.

PART 3 - EXECUTION

3.1 GENERAL

A. Install valves as shown on plans, details and according to manufacturer's installation recommendations.

B. After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

C. Install control valves furnished under Control Systems. Provide increaser and decreaser fittings as required.

D. Refer to Division 23 - Pipe and Pipe Fittings, Part 3 for reducing fittings requirement for valves smaller than pipe size.

E. Provide chain operators for manually operated valves 4" and larger, located more than 10 ft. above equipment room floor.

F. Provide beveled flange adapters or spool pieces as required to ensure complete valve actuation when installed in polypropylene pressure piping.

3.2 SHUT-OFF VALVES

A. Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.

3.3 BALANCING VALVES

A. Provide balancing valves where indicated on drawings and as required for complete balancing of water systems including but not limited to terminal heating/cooling devices, pumps, air handling unit coils, heat exchangers, convertors, and other equipment and at riser takeoffs at each floor.

B. Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

C. Provide balancing valve in return line at riser take-offs at each floor. Provide shut off valve in supply line at each riser take-off.

D. Whenever butterfly or calibrated balancing valves are used for system balancing, an additional shutoff valve meeting requirements of Part 1 shall be provided downstream of balance valve. It is not acceptable to use the balance valve as the shutoff valve.

E. Calibrated balancing valves shall be installed in strict accordance with the manufacturer’s recommendations for orientation, required straight length of upstream and downstream piping, etc. and in no case shall the pressure ports be pointed downward, in order to prevent the accumulation of trash and debris inside the ports. The ports shall be installed in such a manner that allows unobstructed access for the TAB agency to plug into the ports for purposes of measuring and verifying the differential pressure of the valve.

3.4 GAUGE VALVES

A. Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.5 DRAIN VALVES

A. Provide drain valves at all low points of piping systems for complete drainage of systems.

B. Provide drain valves upstream of each floor-level isolation valve.

3.6 WATER PRESSURE REGULATING VALVES

A. Set valves for pressure required or as scheduled.

3.7 WATER RELIEF VALVES

A. Unless otherwise indicated, provide one relief valve in each closed water system in the pump inlet piping.

3.8 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line and elsewhere as detailed.

END OF SECTION 232118

SECTION 232120 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data for all items in this Section including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Materials of construction
4. Dimensional data
5. Capacities/ranges
6. Temperature/pressure ratings
7. Pressure drop
8. All other appropriate data

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, select devices for highest pressures and temperatures existing in respective systems in accordance with ANSI specifications.

B. Piping specialties in copper piping shall have bronze or brass body with solder ends.

2.2 THERMOMETERS

A. Units shall be socket mounted, digital, solar operated panel meters with lux rating of 10 with ABS plastic case and glass passivated thermistor.

B. Display shall be 3/8” LCD and shall be updated every 10 seconds. Unit shall have a minimum range of -40 to 300ºF, an accuracy of 1% of reading or 1ºF whichever is greater.

C. Unit shall operate in ambient temperature range of -30ºF through 140ºF, and humidity range of 0% to 100% non-condensing.

D. Provide thermometers with swivel mounting arrangement to permit up to 45 degrees rotation for easy reading.

E. Provide thermometers with extended necks as required for insulated piping.

F. Range of thermometers shall be:

Service	Scale Range	Increment
Chilled Water	-40°F to 300°F	0.1°F
Heating Hot Water	-40°F to 300°F	0.1°F

G. Thermometers by temperature control manufacturer meeting above specification will be acceptable.

2.3 THERMOMETER SOCKETS AND TEST WELLS

A. Brass construction for carbon steel piping with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series or approved equal.

2.4 PRESSURE GAUGES

A. Manufacturers: Winters, Weksler, Ashcroft, U.S. Gauge, Marsh, Taylor, Trerice, MILJOCO, Marshalltown, or Weiss equal to Trerice 700 Series (liquid filled).

B. Minimum 4" diameter 304 stainless steel case, glass or acrylic plastic window, bronze tube, recalibration from front of gauge dial and 1/4" NPT forged brass socket.

C. Gauge accuracy shall meet ANSI B40.1 Grade A (1% full scale).

D. Reading range of gauges shall be:

Service	Scale Range
Chilled Water	0 to 100 psig
Heating Hot Water	0 to 100 psig

E. Pressure Snubbers:

1. 1/4" or 1/2" size as specified in Division 23 - Pipe and Pipe Fittings, 1000 psig WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

F. Coil Syphons:

1. 1/4" or 1/2" size as specified in Div 23 Section Pipe and Pipe Fittings, 500 psig WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

2.5 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plugs made by Peterson Equipment Company, Sisco, Super Seal by Flow Design Inc. (FDI), or approved equal.

B. Test plugs shall be 1/4" or 1/2" NPT, brass body and cap, 1-1/2" length for non-insulated pipe and 3" length for insulated pipe, with Nordel self-closing valve cores, rated at 500 psig at 275°F, and shall receive either temperature or pressure probe with1/8" OD.

C. Furnish portable test kit within durable case containing the following:

1. A compound pressure gauge, 3-1/2" dial, 30" Hg - 100 psi, field calibration screw, surge protector and stainless steel gauge adapter with 1/8" diameter probe (2% accuracy of mid range).
2. Two pocket testing thermometers, 1-3/4" dial, 5" long stainless steel stem, 0 - 220°F and 25 -125°F ranges with external calibration (1/2% accuracy of entire scale).

2.6 PIPELINE STRAINERS

A. Manufacturers: Metraflex, Mueller Steam Specialty, Hoffman, Hayward, Sarco, Keckley, Armstrong, Wheatley, Conbraco, Watson McDaniel or Streamflo.

B. Liquid System:

1. 2" and Smaller: full pipeline size, "Y" type, with removable screen caps, cast iron, 250 psi WP steam, threaded ends for carbon steel piping and bronze, 150 psi WP steam, solder ends for copper piping. Screen caps shall have threaded blowdown connection.
2. 2-1/2" and Larger: full pipeline size, "Y" type, 125 psi WP steam, cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.
3. Liquid Service Screens: stainless steel with screen perforation as indicated below. Maximum pressure drop shall be 4 ft WG through clean strainer.
4.

Pipe Size	Closed System	Open System
2" and smaller	1/32" (20 mesh)	1/8"
2 1/2" to 4"	1/16"	1/8"
5" and over	1/8"	1/8"

5. Pump suction strainers / diffusers shall be provided with threaded pressure taps on the entering and leaving side of the strainer section for purposes of verifying strainer pressure drop.

2.7 PUMP SUCTION DIFFUSERS

A. Manufacturers: Bell & Gossett, Taco, Armstrong, Wheatley, Mueller Steam Specialty

B. Cast iron or ductile iron body with angle pattern flow straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16” diameter openings, 175 psig WP, at 250°F. Threaded ends for 2” and smaller and flanged ends for 2-1/2” and larger. Orifice cylinder shall have free area of at least 5 times cross section area of pump suction opening. Furnish each unit with disposable fine mesh start-up strainers, gauge tappings, blow down connection, and adjustable support foot to carry weight of suction piping.

C. Pump suction diffusers manufactured by grooved coupling manufacturer will be acceptable where grooved pipe connection system is allowed.

2.8 AIR AND DIRT SEPARATORS

A. Manufacturers: Spirovent, Bell & Gossett, TACO or Wessels.

B. Coalescing type combination air and dirt separator, designed for maximum 150 psig WP, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. Connections 2-1/2” and larger shall be flanged. Smaller connections may be flanged or threaded. Inlet size shall be no smaller than scheduled size. Inlet velocity shall be 4.0 feet per second or less.

C. Coalescing medium shall consist of copper core tubes or stainless steel tubes with enhanced surface to facilitate coalescing action.

D. Coalescing medium shall be removable for inspection.

E. Unit air and dirt removal performance shall be certified by independent third-party testing agency.

1. Air elimination efficiency shall be 100% of free air, 100% of entrained air, and 99.6% of dissolved air.
2. Dirt separation efficiency shall be 80% of particles 30 microns and larger within 100 passes.

F. Venting chamber shall be provided with integral full port float actuated brass venting mechanism.

G. Unit shall include valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

H. Drain valve at bottom of unit for flushing/dirt removal, 2” for units size 3” and smaller, 3” for units size 3” and above.

2.9 AIR VENTS

A. Manual Air Vents:

1. Manufacturers: HCi, Taco, Meetraflex or Bell & Gossett.
2. Coin operated air vent, 125 psig at 210°F. Use 1/2" ball valve for main pipes.

B. Automatic Air Vents:

1. Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman.
2. Metal construction, non-corrosive working parts, 150 psig WP at 240°F.
3. Normal capacity vent shall be similar to B&G Model 87.
4. High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig, similar to B&G Model 107A.

2.10 VACUUM RELIEF/BREAKERS

A. Kadant Johnson Series VB-8 with brass body, stainless steel ball, EPR seat, stainless steel spring, suitable for pressures to 300 psig at 365°F, or Bell and Gossett Model No. 26, 150 psig at 240°F.

2.11 STRAIGHTENING VANES

A. Straightening vane assembly shall consist of series of carbon steel pipes firmly welded together and to line size pipe. Furnish vanes with class 150 psi flanges for insertion into piping system

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties as indicated on plans, details and according to manufacturer's recommendations.

B. Install pressure gauges and thermometers in readily accessible locations in piping adjacent to the equipment served, such that they can be easily read from a standing position on the floor (do not install any higher than 7’-0” AFF) but also minimize risk of damage due to accidental contact. Gauges shall be installed in the entering and leaving side of all service piping. Install P/T ports on the entering and leaving side of all hydronic heat transfer coils, control valves, flow meters, pumps, adjacent to each pressure gauge and thermometer, and upstream and downstream of each differential pressure flow device, etc. Flow devices shall be installed in strict accordance with the manufacturer’s recommendations for orientation, required straight length of upstream and downstream piping, etc. and in no case shall the pressure ports be pointed downward, in order to prevent the accumulation of trash and debris inside the ports. The ports shall be installed in such a manner that allows unobstructed access for the TAB contractor to plug into the ports for purposes of measuring and verifying the differential pressure of the valve. Installation of gauge cocks and P/T ports shall be used to facilitate the “Sensor Calibration Check” phase of the functional performance testing (FPT).

C. Flow measuring stations, flow elements and meters shall be installed in strict accordance with the manufacturer's recommendations for orientation, required straight length of upstream and downstream piping, etc. and in no case shall the pressure ports be pointed downward, in order to prevent the accumulation of trash and debris inside the ports. The ports shall be installed in such a manner that allows unobstructed access for the TAB agency to plug into the ports for purposes of measuring and verifying the differential pressure of the valve.

3.2 THERMOMETERS

A. Install thermometers in thermowells sockets in locations indicated.

3.3 THERMOMETER TEST WELLS

A. Install test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

B. Install fittings for side mounting to avoid collection of air or dirt.

3.4 PRESSURE GAUGES

A. Install gauges for services other than steam with pressure snubbers and gauge valves.

3.5 PRESSURE GAUGE TAPPING

A. Install tappings at each point where sensing device is required under Control Systems and at gauge locations as shown.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.6 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.7 PIPELINE STRAINERS

A. Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.

B. Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

3.8 AIR VENTS

A. Install manual air vents at all high points in water systems where air may collect and where shown on drawings.

B. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain.

3.9 PUMP SUCTION DIFFUSERS

A. Pipe blow down to the nearest floor drain with drain valve at unit.

B. Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

C. Support pump suction diffuser independently from piping using floor mounted support.

3.10 AIR AND DIRT SEPARATORS

A. Provide valved blow down connections and extend drain piping to nearest floor drain.

3.11 FLOW SENSORS / FLOWMETERS

A. Flow sensors located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.

B. If flow sensors/flow meters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters shall be done by Control Contractor.

3.12 PUMP SUCTION DIFFUSERS

A. Pipe blow down to the nearest floor drain with drain valve at unit.

B. Remove disposable fine mesh start-up strainers after start-up. Clean permanent strainer and replace after pipe cleaning process.

C. Support pump suction diffuser independently from piping using floor mounted support.

END OF SECTION 232120

SECTION 232514 - CHEMICAL TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop drawings for each system including, but not limited to, the following:

1. Manufacturer's name and model number
2. Capacities / ratings
3. Chemicals; description of chemicals, its composition and function
4. Materials of construction
5. Dimensions and weights
6. All other appropriate data

B. Submit complete make-up water analysis.

C. Submit directly to Owner, Material Safety Data Sheets (MSDS) for all chemicals used in chemical treatment systems. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.

1.2 OPERATION AND MAINTENANCE DATA

A. Provide for services of manufacturer's trained, representative to approve installation, and instruct Owner's representative in operation, testing and maintenance of each system.

1.3 WATER ANALYSIS

A. Submit complete water analysis and results of performance test of each system signed by manufacturer's service representative.

B. Water analysis shall include the following:

1. Hot Water and Chilled Water:

   a. Hardness
   b. pH
   c. "M" alkalinity
   d. Inhibitor level
   e. Total dissolved solids
   f. Temperature

1.4 WATER QUALITY REQUIREMENTS

A. Minimum water quality requirements for closed hot and/or chilled water systems shall be as follows:

1.	pH	8.0 – 9.0
2.	TDS	< 500 mg/L(ppm)
3.	Hardness as CaCO3 and Alkalinity	< 120 mg/L (ppm)
4.	Chlorides	< 200 mg/L(ppm)
5.	Sulphates	< 200 mg/L(ppm)
6.	Iron	< 1.0 mg/L(ppm)
7.	Dissolved Oxygen	<0.1 mg/L(ppm)
8.	Ryznar Index	>6.0

9. Suspended Solids ≤10 µm(micron)
10. Bacteria Counts
    a. Total aerobic bacteria counts ≤100 cfu per mL
    b. Total anaerobic bacteria counts <10 cfu per mL

1.5 DESIGN CRITERIA

A. Periodic test procedure and chemical shall be recommended for each system.

B. Chemical shall be suitable for pipe material, fluid medium and intended treatment.

C. Treat the following systems:
    1. Hot water
    2. Chilled Water

D. Provide initial chemical treatment and equipment for all systems based on complete system fluid analysis including makeup water prior to equipment installation.

E. Initial supply of chemicals for chemical treatment of each system shall be adequate for start up and testing period, for the time systems are being operated by Contractor for temporary heating and cooling, and for one year after start-up of system.

F. Inhibitor for closed water systems shall use nitrites or molybdate as primary inhibitor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: ChemTreat, Betz-Dearborn, Diversey Water Technologies, Nalco, HOH Chemical, or Ecolab.

2.2 PIPING SYSTEM CLEANER

A. Use cleaning compound similar to Nalco 2567 to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system metals without deleterious effects. Cleaner shall not contain phosphate.

2.3 CHILLED AND HOT WATER CHEMICAL TREATMENT

A. Provide by-pass type batch feeder to receive chemicals in liquid or pellet form. Chemical treatment shall control corrosion, scale, and biological growths.

B. Feeder shall have minimum capacity of 5 gal and shall be constructed of steel with minimum working pressure of 150 psig. Feeder shall be complete with air vent, drain valve, and inlet/outlet pipe connections.

C. Furnish feeders with screw type cover with replacement gaskets, or valved funnel opening and with exterior prime coat finish.

2.4 TEST CABINET AND EQUIPMENT

A. Provide complete chemical treatment test equipment and cabinet with appropriate reagent, burettes, and glassware to conduct all tests necessary for determination of proper treatment and blowdown.

B. Provide detailed, written test procedures for each system in manual with plastic protection cover for each page.

C. Test equipment shall include but not be limited to, the following:

1. Closed Loop Water System:

a. Inhibitor test kits

PART 3 - EXECUTION

3.1 APPLICATION OF CHEMICALS

A. Apply initial chemical treatment for each system after systems have been cleaned and flushed.

B. Add, adjust or modify treatment based on results of period tests until turned over to Owner.

3.2 PERFORMANCE TEST

A. Conduct performance test for each system to determine required capacity and performance of chemical treatment system. Refer to Part 1 for water analysis and water quality requirements.

B. Conduct water quality test in all systems weekly and submit test result reports to Mechanical Contractor and Owner until project is turned over to Owner.

C. Conduct water quality tests before and after new work tie-in to existing systems.

3.3 BATCH FEEDERS

A. Install in bypass arrangement at pump discharge.

B. Install ball valve in inlet line, balancing valve in outlet line and unions.

3.4 PIPE CLEANING

A. General:

1. Systems are to be cleaned before they are used for any purpose except pressure test which shall be conducted before cleaning. Add cleaner to closed systems at concentrations as recommended by cleaner manufacturer. Remove water filter elements from system before starting circulation.
2. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.
3. Remove, clean, and replace strainer screens or filters.
4. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed.

5. New water piping systems within the scope of work for this project shall not be connected to any existing piping systems until flushing and cleaning have been completed and test reports have been sent to Engineer for review. Obtain written permission from Owner prior to opening up new work to existing systems. Once Owner approval is given, UNCW Facilities Services personnel shall be present when tie-in to existing systems is made.

B. Water Systems:

1. Piping system shall be filled, vented and circulated employing chemical cleaner solution for period of at least 24 hrs or more in accordance with manufacturers recommendations and job site chemical tests. Bring concentration to level which raises M Alkalinity to manufacturer's recommended value above that for existing water used for fill. Conduct chemical tests to verify levels and submit results to Architect/Engineer. Flush detergent clear with continuous draining and raw water fill for period of at least 12 hrs or more until original M Alkalinity level is achieved (or pH of system water is within 0.5 pH of make-up water). Conduct chemical tests to verify levels and submit results to Architect/Engineer. When cleaning process is complete, replace strainers or filters and reconnect permanent pumping apparatus.

C. Upon completion of flushing and cleaning and before tie-in to existing piping systems, Chemical Treatment Contractor shall submit written report to Engineer indicating successful completion of pipe cleaning and chemical treatment including all forms and test data specified.

END OF SECTION 232514

SECTION 233114 - DUCTWORK

PART 1 - GENERAL

1.1 SUBMITTALS

A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards where applicable. Each duct system schedule shall include, but not be limited to, the following:

1. Name of Contractor/manufacturer fabricating each duct system.
2. Material and gauge.
3. Pressure class.
4. Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system.
5. Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures.
6. Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge.
7. Type of longitudinal seam.
8. Fitting construction details.
9. Support methods including spacing, upper attachments, and lower attachments.
10. Sealant and gasket.
11. Sealing class.

B. Duct leakage testing methods, apparatus and apparatus certification.

1.2 DESCRIPTION

A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.

B. Duct sizes indicated are net inside dimensions.

C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.3 DESIGN CRITERIA

A. All products shall conform to ASTM E84 or UL 723, and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Ductwork shall comply with local, state and Federal requirements.

C. Unless otherwise indicated, construct ductwork to meet functional criteria defined in Chapter 11 of SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005.

D. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than +2" WG for positive pressure ductwork and not less than -2” WG for negative pressure ductwork.

E. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal device inlet shall be equal to static pressure at fan discharge but not less than 4" WG; pressure class for ductwork on suction side of air handling unit and suction side of return fan shall be equal to static pressure at inlet of return fan but not less than -2" WG.

F. Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less than + or - 2" WG.

G. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.

H. Except as modified in this Section, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:

1. HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10" WG and negative 10" WG and flat oval ductwork up to positive 10" WG.

   a. Internal tie rods or bracing are not allowed for ductwork 36” and smaller. Tie rods shall be 1/2", 3/4", 1” , 1-1/4” or 1-1/2” galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
   b. Internal tie rods are not allowed for ductwork in chase and other non-accessible spaces.
   c. Midpanel tie rods described in SMACNA Addendum No. 1, November 1997, are not allowed.

2. Round Industrial Duct Construction Standards, 2nd Printing 1999.
3. Accepted Industry Practice for Industrial Duct Construction, 1st Edition, 4th Printing, 1988, for round ductwork -4" to -20" WG (Table 1-A) and for rectangular ductwork -4" to -20" WG (Table 2-A).

1.4 WELDING REQUIREMENTS

A. The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.

B. Procedure and Qualification:

1. Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by installing contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.
2. Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.
3. Establish and provide written quality assurance/quality control (QA/QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

B. If ductwork will be stored onsite, elevate duct above floors and maintain protection on ends.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL SHEET

A. First quality, lock former quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924 (formerly ASTM A525) or ASTM A653 (formerly ASTM A527). Galvanized coating shall be G90.

B. Use G 90 galvaneal or Zincgrip where painting is specified.

2.2 FLEXIBLE DUCT

A. Manufacturers: Flexmaster, Thermaflex, or Casco, similar to Flexmaster Type 6 (Insulated).

B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of ASTM E84 or UL 723 with flame spread of 25 or less and smoke developed rating of 50 or under.

C. Flexible duct shall be suitable for:

1. Operating Temperature: -20 to 250°F
2. Operating Pressure: -1” to +6" WG
3. Rated Velocity (Min): 4,000 fpm

D. Duct fabric shall be nonmetallic type composed of chlorinated polyethylene (insulated) or coated woven fiberglass (non-insulated) bonded permanently to corrosion resistant coated steel wire helix.

E. Flexible duct shall be minimum 1" fiberglass insulation blanket with maximum thermal conductance of 0.23 K at 75°F. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with minimum perm rating of 0.05 perm.

F. Insulation material shall not be exposed to air stream.

G. Flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 6 ft straight duct shall not be less than the following:

Duct Diameter (in.)	Dynamic Insertion Loss (dB) Octave Band Center Frequency (Hz) (Based on 6 ft length @ 2,500 fpm)					
	125	250	500	1000	2000	4000
6	13	15	15	16	17	16
8	14	13	15	16	18	16
12	13	12	15	15	18	13

2.3 MANUFACTURED ROUND OR FLAT OVAL DUCTWORK (Positive Pressure)

A. Single Wall:

1. Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of galvanized steel meeting ASTM A-653. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80" diameter with minimum 16 ga. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
2. Unless otherwise indicated, connection shall be slip type with minimum 2" insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
3. Internal bracing is not allowed.

2.4 MANUFACTURED ROUND DUCTWORK (Negative Pressure)

A. Single Wall:

1. Ducts shall be machine formed round duct constructed of galvanized steel meeting ASTM A-653 or Type 304 stainless steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
2. Connection shall use slip coupling, angle ring or Van Stone connectors in accordance with manufacturer's recommendations.
3. Round spiral duct gauge/reinforcement shall be per SMACNA duct construction standards.
4. Fitting gauge shall be one even gauge heavier than the lightest allowable gauge of connecting downstream section of duct.

2.5 MANUFACTURED SELF-SEALING ROUND DUCTWORK SYSTEM

A. Single-wall:

1. Duct system shall consist of fittings with factory-fitted sealing gasket and spiral duct which will seal duct joints without use of duct sealer.
2. Ducts shall be machine formed round as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
3. Unless otherwise noted, duct and fittings shall be constructed per SMACNA's Duct Construction Standards (+10 in WG) shown in the following table:

Diameter (inches)	Galvanized Spiral Duct	Galvanized Fittings
3-14	26	24
16-26	24	22
28.36	22	20
38-50	20	20

4. All fitting ends shall have factory equipped with double-lipped, U-profile or tubular EPDM rubber gasket. Gasket shall be classified by Internationally Recognized Laboratory Authority to conform to ASTM E84 or UL 723 flame spread and smoke developed ratings of 25/50.
5. Ductwork system performance shall meet SMACNA's Leakage Class 3 Requirements from -20" WG to +12" WG.

2.6 STAINLESS STEEL SHEET

A. First quality, cold rolled annealed, pickled, ASTM A240 and A480, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 304L where welded duct construction is specified and Type 304 where non-welded duct construction is allowed.

2.7 DUCT SEALANT AND GASKET

A. Sealant:

1. UL Classified sealant as compounded specifically for sealing joints and seams in ductwork. Hardcast, United McGill, Ductmate, Mon-Eco Industries or H.B. Fuller/Foster. Duct tapes are not allowed.
2. Select sealants as recommended by manufacturer for specific application.
3. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, detailed installation instructions.
4. Sealant must comply with USGBC LEED v3.0 Indoor Environmental Quality (IEQ) credit 4.1 for low VOC Adhesives and Sealants.

B. Gaskets:

1. Butyl, copolymer or neoprene based tape similar to Ductmate 440 Gasket Tape or Neoprene Gasket Tape for flanged joints.

2.8 CABLE SUSPENSION SYSTEM

A. Suspension system shall be Gripple Hang-Fast as manufactured and supplied by Gripple Incorporated or Ductmate Industries “Clutcher” cable hanging system.

B. Suspension system shall be load rated and verified by SMACNA Testing and Research Institute to be in compliance with SMACNA HVAC Duct Construction Standards, 2005, Chapter 5.

PART 3 - EXECUTION

3.1 GENERAL

A. Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment and access clearances for cable tray/j-hooks. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.

B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Designer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Designer and obtain written approval from Designer and Owner. Ducts need not be enlarged if decrease in area does not exceed 10%. If decrease in area would exceed 10%, enlarge duct to maintain duct area not less than 90% of that shown on drawings. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.

C. Ductwork shall be free of kinks and dents.

D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, liner, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this Section.

E. Provide transitions where different size or different shape ductwork segments are connected. Unless otherwise indicated, make diverging transitions with maximum angle of 15 degrees per side (30 degrees total diverging) and converging transitions with maximum angle of 25 degrees per side (50 degrees total converging).

F. Provide transitions at ductwork system components and connections to equipment.

G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.

H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.

I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

J. Support coils, filters, air terminals, dampers or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.

K. Do not support air terminal devices with strap hangers. All air terminals shall be supported by trapeze hanger with threaded rod. Refer to Section 230529 – Mechanical Supporting Devices for additional requirements.

L. Install outside air intake duct to pitch down at 1" per 20 ft toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.

M. Blank off unused portion of outside air intake or exhaust louvers.

N. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.

O. Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified in Division 23 - Control Systems Integration.

P. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.

Q. Do not route ductwork over MDF/IDF/Electrical rooms except where duct serves the room.

R. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:

1. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.
2. Apply cold galvanizing material equal to ZRC Products, Inc.

3.2 ELBOWS

A. Rectangular Duct (SA/RA/EA):

1. Use radius elbows with centerline radius to width ratio of 1.0 (SMACNA Type RE 3).
2. Where 1.0 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 0.75 (SMACNA Type RE 3) or 45° throat with radius heel elbows (SMACNA Type RE 8).

3. Use splitter vanes for 1.0 radius elbows, 0.75 radius elbows and 45° throat with radius heel elbows as follows;
   a. No vanes for duct with width less 24”
   b. Single vane for duct with width 24” to 36”
   c. Two vanes for duct with width over 36”
4. Fabricate splitter vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).
5. Square throat elbows with or without turning vanes are not allowed unless specifically indicated. Square throat elbows without turning vanes may be used for transfer air ducts.

B. Round and Oval Duct:

1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.3 LONGITUDINAL SEAM

A. Rectangular Duct:

1. Unless otherwise indicated, use Pittsburgh lock seam for rectangular ductwork except button punch snap lock may be used for ductwork downstream of supply air terminal devices.
2. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceilings.
3. Button punch snap lock construction is not allowed on aluminum ductwork.
4. Seal longitudinal seams with approved sealant or provide pre-sealed from factory with encapsulated mastic.

B. Round and Oval Duct:

1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards. Snaplock seams are not allowed.

3.4 TRANSVERSE JOINT

A. Rectangular Duct:

1. Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.
2. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.
3. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of latest edition of SMACNA HVAC Duct Construction Standards Metal and Flexible, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2 x 1-1/2 x 1/4 angle at each side of transverse joint.

B. Round or Flat Oval Duct:

1. Unless otherwise indicated, use beaded sleeve joints (SMACNA RT-1) with minimum 2" insertion length or flange joints (SMACNA RT-2 or RT-2A).
2. Connection systems manufactured by Ductmate Industries (Spiralmate and Ovalmate) may be used for supply air ductwork.
3. AccuFlange connected systems may be used with gaskets specified in Part 2 of this Section.
4. Manufactured Self Sealing Round duct system will be acceptable for supply and return air ductwork.

3.5 DUCT SUPPORTS

A. Unless otherwise indicated, use straps or Z bar hangers with 3/8” rods to support rectangular ducts 60” wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60” wide.

1. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Division 23 - Mechanical Systems Insulation and details.

B. For round ducts 24"diameter or smaller, use single hanger.

1. Cable Suspension System may be used up to 16" diameter.
2. Round Duct Strap Bracket by Ductmate Industries may be used up to 24"diameter.

C. For round ducts over 24" diameter, use 2 hangers with half round trapeze.

D. For round ducts over 25” diameter or larger, use 2 minimum 3/8” rods, with trapeze in accordance with the following schedule:

Duct Size	Trapeze (Half Round)
25” through 36”	1-1/2” x 1-1/2” x 1/8”
37" through 48"	1-1/2" x 1-1/2" x 1/4"
49" through 60"	2" x 2" x 1/4"
61" through 84"	2-1/2" x 2-1/2" x 1/4"

E. Refer to Division 23 - Mechanical Systems Insulation, for ductwork insulation, weight bearing inserts and insulation protection shield requirements.

F. Support vertical ducts at every floor, but not exceeding 12 ft.

G. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:

1. Hook or loop.
2. Nailed pin fasteners.
3. Expansion nails without washers.
4. Powder charged or mechanically driven fasteners (forced entry anchors).
5. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps).
6. Friction clamps for ductwork over 12".
7. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 4-3 of SMACNA HVAC Duct Construction Standards 95).
8. Wire hanger.
9. Trapeze hangers supported by wires or straps.
10. Rods, straps or welded studs directly attached to metal deck.
11. Drilled hole with attachment to structural steel.
12. Lag screw expansion anchor.
13. Rivets.

H. Supporting devices shall be standard products of manufacturers having published load ratings.

I. Refer to Division 23 - Mechanical Supporting Devices, for additional support requirements including attachments to structures.

J. For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.

K. Unless drawings indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with Structural Engineer for location and size of opening prior to execution of Work.

3.6 SHEET METAL WELDING

A. SMACNA T-21 or T-21a welded flange joints are acceptable with continuous welding including at each corner for rectangular ducts.

B. Attach welding cable leads directly to base metal to be welded. Do not jumper welding cable leads through building structure, to avoid emission of stray voltage/current through building structure.

C. Welds on exposed ductwork in occupied spaces shall be brush polished with stainless steel brush.

D. Welds at exterior of building shall be ground smooth and brush polished with stainless steel brush to prevent atmospheric contamination and rust formation.

3.7 PROTECTION OF DUCTWORK

A. The installing contractors must take appropriate precautions, during construction, to prevent unnecessary dirt, dust and debris from getting into air handling systems by covering equipment, controls and open-ended ducts while being stored on site and as the installation progresses.

B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.

C. Remove dirt and foreign matter from entire duct system and clean diffusers, registers and grilles before operating fans.

D. Return fans are not allowed to operate during construction to avoid intake of construction dirt/dust into return air ductwork. Cover all return/exhaust air inlets with minimum MERV 8 filters prior to operation of return/exhaust fans.

3.8 LEAKAGE TEST

A. Refer to test and balancing portion of Division 23 - General Mechanical Requirements.

B. Owner, Engineer, CxA or CM may elect to witness leakage tests. Notify Owner, Engineer, CxA or CM at least 3 days in advance.

C. Test 25% of supply, return, and exhaust ductwork from fan to air terminal devices where air terminal devices are used, unless otherwise indicated in this section.

D. Leakage test shall be in accordance with test method described in Section 3 of SMACNA HVAC Air Duct Leakage Test Manual, except as modified in this Section. Test apparatus shall be in accordance with Section 5 of SMACNA HVAC Air Duct Leakage Test Manual

E. Test pressure shall be equal to duct pressure class. Negative pressure ductwork shall be tested with negative test pressure.

F. Air leakage shall not exceed limits specified. If leakage exceeds allowable limits, identify leaked areas, repair, seal and retest.

G. Provide filter system on duct inlet to test blower. Filter system shall be equal to final filtering efficiency of AHU supply air duct system. Filters are not required for negative pressure testing.

H. Do not insulate ductwork until it has been successfully tested.

I. Allowable leakage rates of each ductwork (L) in cfm/100 sf duct surface area shall be calculated by:

1. L = CL x P0.65
2. P = test pressure (duct pressure class).
3. CL = duct leakage class, 3 for ductwork 3” WG and over and 6 for ductwork 2” WG and lower.
4. Total allowable leakage in a duct section:

   a. = L x (total duct surface area of the section)

J. Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below:

1. When using test apparatus and procedure described in SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:

   a. 1 cfm per 1” WG of static pressure is allowed for the test equipment and test connections (e.g. 3 cfm when testing at 3” WG).
   b. 0.10 cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm for a cap on 10” diameter duct).

2. To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Client’s Representative and repaired by welding. No caulking or sealing is allowed.

K. Leakage Test for Ductwork Downstream of Air Terminal Devices:

1. Representative samples of ductwork (approximately 10% of total linear feet of ductwork) shall require leakage test.
2. Designer will decide samples of ductwork to be tested and date of leakage test to be conducted after completion of ductwork installation on a floor by floor basis.
3. Submit results of each test to Designer within 3 days of test occurrence for Designer’s review. Contractor shall retest when equipment or system fails to meet minimum requirements after proper repairs are made.
4. If test results are acceptable to Designer, remainder of ductwork is permitted to proceed without further testing. If ductwork fails test, repair all ductwork including ductwork not tested. Then repeat leakage tests for new samples of ductwork as described above.

3.9 LOW PRESSURE DUCT CONSTRUCTION (Pressure Class 2" and under)

A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2" into duct. Sheet metal "TEK" screws 3/4" in length may be used as fasteners in conjunction with factory made transverse joints.

B. Unless otherwise indicated, construct branch take-off fittings as follows:

1. For branch take-offs including branch ducts serving more than one diffuser or grille, use 45 degree entry fittings. For supply air ducts, expanded or conical taps may be used.
2. For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.

C. Do not use splitter dampers and/or extractors unless manual volume dampers alone do not accomplish the intended balancing. Obtain Designer's written approval before installing them. Use of splitter dampers and/or extractors will not eliminate need for specified or indicated manual volume dampers.

D. Use of duct liner material of any type shall not be permitted.

3.10 HIGH PRESSURE DUCT CONSTRUCTION (Pressure Class 3" and over)

A. Use manufactured ductwork or Contractor fabricated ductwork meeting specified Construction Standards.

B. Submit construction details including materials, type of service, reinforcing methods, and sealing procedures.

C. Use elbows, tees, laterals, crosses and accessory fittings as shown on drawings and as required to fabricate duct system.

D. Use of duct liner material of any type shall not be permitted.

E. Use expanded or conical tees for branch round or flat oval take-offs from mains and 45-degree entry fittings for branch rectangular takeoffs from mains unless otherwise indicated.

F. Provide manufactured bellmouth fittings at each fan supply air plenum to provide smooth entrance of air into duct system.

3.11 FLEXIBLE DUCT

A. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section.

B. In supply air systems with air terminal devices, insulated flexible ducts shall be used for duct connections to diffusers, grilles, and registers for sound attenuation purposes. Flexible ducts shall be minimum 3 ft long and maximum 6 ft long, unless noted otherwise.

C. Insulated flexible ducts may be used for final connections to return, exhaust, and transfer grilles and registers. Flexible ducts shall be minimum 3 ft long and maximum 6 ft long, unless noted otherwise.

D. Centerline radius of bends shall not be less than one duct diameters.

E. Support flexible ductwork at a maximum of 3 ft on center, with no portion lying on ceiling supporting system.

F. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.

G. Connect flexible duct liner to collars with draw bands. If collars have beads, position draw bands behind beads.

H. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.

I. Flexible ducts are not allowed in high pressure ductwork.

J. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.12 DUCTWORK PAINTING

A. Above ceiling ductwork that is visible from the occupied "finished" space shall be painted.

3.13 DUCT CONSTRUCTION MATERIAL AND PRESSURE CLASSIFICATION

A. Ductwork shall be constructed from the following materials and for the pressure class as follows, unless otherwise noted:

Supply Air Ductwork	Material	Pressure Class							
	Galvanized	+2" WC	+4" WC	+6" WC	+10" WC	-2" WC	-4" WC	-6" WC	-10" WC
OA Plenum to AHU	X						X		
AHU to Fire/Smoke Dampers at each floor	X			X					
Fire/Smoke Dampers at Shaft Wall to Air Terminal Unit	X		X						
Air Terminal Unit to Air Device	X	X							

Return Air Ductwork	Material	Pressure Class							
	Galvanized	+2" WC	+4" WC	+6" WC	+10" WC	-2" WC	-4" WC	-6" WC	-10" WC
AHU to Fire/Smoke Dampers at each floor	X						X		
Fire/Smoke Dampers at Shaft Wall to Air Device	X					X			

Exhaust Air Ductwork	Material	Pressure Class							
	Galvanized	+2" WC	+4" WC	+6" WC	+10" WC	-2" WC	-4" WC	-6" WC	-10" WC
General exhaust fan to duct main shaft penetration	X						X		
General exhaust main penetration at Shaft Wall to Air Device	X					X			

END OF SECTION 233114

SECTION 233314 - DUCTWORK SPECIALTIES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data including, but not limited to, the following:

1. Manufacturer's name and model number
2. Capacities
3. Temperature/pressure ratings
4. Materials of construction
5. Dimensions
6. Manufacturer's installation instructions and/or detailed drawings
7. All other appropriate data

B. Manufacturer's installation instructions and details of fire dampers and combination fire and smoke dampers.

1.2 DESIGN CRITERIA

A. Products and materials shall conform to ASTM E84 or UL 723, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct at where the specialties are mounted, unless otherwise noted.

C. Unless otherwise noted, ductwork specialties shall be designed and manufactured to conform to same pressure class as ductwork in which they are installed.

PART 2 - PRODUCTS

2.1 MANUAL BALANCING DAMPERS

A. Manufacturers: Ruskin, Greenheck, Nailor, Cesco, Vent Products, or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.

B. Round Dampers:

1. Frame: 20 ga (min) galvanized steel.
2. Blade: 20 ga (min) galvanized steel.
3. Bearings: Corrosion resistant, molded synthetic.
4. Axle: Continuous 3/8” (min) square axle shaft extending through factory mounted locking regulator.
5. Regulator: Provide acorn nut type locking regulator with position indicator.

C. Rectangular Dampers (Single & Multiple Blade):

1. Frame: 16 ga (min) galvanized steel channel with reinforced corner braces.
2. Blades: 16 ga (min) galvanized steel with V-grooved reinforcement and blade stops.
3. Bearings: Corrosion resistant, molded synthetic.
4. Axles: 1/2” (min) hexagonal shaft extending through factory mounted locking regulator.
5. Regulator: Provide acorn nut type locking regulator with position indicator.

D. Sheet metal screws are not allowed in construction of dampers. Use rivets or tack welds.

E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.

F. Use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

2.2 BACKDRAFT DAMPERS

A. Manufacturers: Ruskin, Greenheck, Nailor, Cesco, Vent Products, or Air Balance.

B. Dampers shall be multi-blade, weighted type with counter-balanced blades and with galvanized steel or aluminum frame equal to Ruskin Type CBD-4. Blade edges to have vinyl gasket or polyurethane foam seals with ball bearings. Dampers to be suitable for flange and gasket connection to ductwork.

2.3 FIRE DAMPERS

A. Manufacturers: Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff Louvers and Dampers, or Ruskin

B. Minimum damper size is 12” x 12”.

C. Fire damper assemblies shall be listed by UL 555 with 165°F fusible link and shall meet construction standards as set forth in NFPA 90A.

D. Fire resistance rating of fire dampers shall be as shown on drawings.

E. Dampers shall be dynamic type dampers rated to minimum 2000 fpm and 4” WG.

F. Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers.

G. For round ducts, dampers similar to Ruskin Model FDR25 may be used where products are suitable for duct size, velocity and static pressure.

H. Damper fire rating shall be compatible with rating of building surface in which damper is used.

I. Where ceiling fire dampers are used, they shall be similar to Ruskin CFD2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Ruskin, Air Balance, Prefco, Greenheck, Nailor, Cesco, or Pottorff, Louvers and Dampers similar to Ruskin FSD-60

B. Minimum damper size is 12” x 12”.

C. Dampers shall meet requirements of NFPA 90A. Dampers shall be 1-1/2 or 3 h rated as shown on drawings, leakage rated at no higher than leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555/555S at temperature category 350°F, and compatible with system static pressures. Furnish dampers with factory-mounted, caulked sleeves and damper operators.

D. Dampers shall use airfoil shaped damper blades. Dampers shall be rated for minimum 4” WG static pressure and 2000 fpm air velocity.

E. For round ducts, dampers equal to Ruskin Model FSDR 25 may be used.

F. Operators shall be 120 V electric powered with auxiliary switch built in for position indication factory installed outside airstream, linked to dampers for fail closed operation, and be UL Listed and labeled for the application. Operators to be capable of closing damper at pressures encountered in system. Electric operators shall be rated for energized hold open position period of 6 months or more.

G. Dampers shall be furnished with:

1. Test switch similar to Ruskin Model DTS.
2. Heat sensor set at 165°F.
3. Position switch to indicate actual damper position for monitoring by control system.

H. Smoke detector required at each damper will be provided by Division 28 Contractor.

2.5 SMOKE DAMPERS

A. Manufacturers: Air Balance, Johnson Controls, Ruskin, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff, Louvers and Dampers, or Prefco, similar to Ruskin SD-60.

B. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 4” WG in closed position and to 2000 fpm in open position.

C. For round ducts, dampers equal to Ruskin Model SDRS 25 may be used.

D. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.

E. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

F. Actuators shall be 120 V electric powered with auxiliary switch built in for position indication.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Smoke detector required at each damper will be provided by Division 28 Contractor.

2.6 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Round butterfly or rectangular opposed blade damper designed for external cable control.

B. Damper control cable shall be 0.054” stainless steel control wire encapsulated in 1/16” flexible galvanized spiral wire sheath with a maximum length of 50 ft.

C. Control kit shall consist of 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion to operate connected damper. Control shaft shall be D-style flatted 1/4” diameter with 265 degree rotation providing graduations for positive locking and control, and 1-1/2” linear travel capability.

D. Furnish two wrenches from system manufacturer capable of adjusting damper controllers.

2.7 ACCESS DOORS

A. Access doors shall be rectangular, sturdy, fit air tight with gasket and shall be suitable for duct pressure class. Doors shall be at least the same gauge as ductwork and be made of the same material. Doors shall be double-wall, insulated when installed in insulated ductwork or unit casing and located for greatest ease of access. Round access doors are not acceptable. Access doors constructed with sheet metal screw fasteners are not acceptable.

B. Low Pressure Ducts (Pressure Class 2" and Under):

1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.
2. Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.
3. Access doors made by Ductmate, Greenheck, Flexmaster, or Ward Industries are acceptable, provided that they meet insulation requirements and include edge protection.

C. High Pressure Ducts (Pressure Class 3" and Over):

1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.
2. Use access doors factory fabricated and rated by manufacturer's published literature for installation in systems with pressures to positive or negative 10" WG.
3. Access doors made by Ductmate, Pottorf, Greenheck, Flexmaster, or Ward Industries are acceptable, provided that they meet insulation requirements and include edge protection.

2.8 TURNING VANES

A. Radius Elbow Splitter Vanes:

1. Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.

B. Square Throat Elbow Turning Vanes (Vane Runner Length up to 18" and Vane Length up to 36"):

1. Use single blade type vanes having 2" radius and 1-1/2" spacing, 24 gauge minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.
2. If duct size changes in mitered elbow, use single blade type vanes with trailing edge extension.

C. Square Throat Elbow Turning Vanes (Vane Runner Length over 18" or Vane Length over 36"):

1. Use double wall airfoil type with smoothly-rounded entry nose and extended trailing edge on 2.4" center spacing.
2. Vanes shall be equal to HEP (High Efficiency Profile) vanes as manufactured by Aero/Dyne Co.

2.9 DUCT FLEXIBLE CONNECTIONS

A. Manufacturers: Ventfabrics, Inc., Duro Dyne or Ductmate. Material shall be glass fabric, fire retardant, waterproof, air tight and comply with UL Standard 214, ASTM E84 and UL 723.

B. General Supply, Return and Exhaust Ductwork:

1. Material for indoor use to be 30 ounce per square yard, double coated with neoprene, suitable for -20 to 200°F continuous operation equal to Ventglas.

2.10 SOUND ATTENUATING DEVICES

A. Manufacturers: Semco, United McGill, Aeroacoustic, Vibro-Acoustics, VAW Systems, Price, or Ruskin

B. Units shall be tested in accordance with ASTM E-477-99 silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-99 Standard. Each test shall have been conducted within last 12-month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.

C. Outer casing of units shall be not less than 22 ga G90 galvanized steel in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork for 8” WG or pressure class indicated for duct system, if it is higher than 8” WG. Seams shall be lock formed or continuously welded and mastic filled.

D. Acoustic Materials:

1. Media shall be long fiber fiberglass protected with covering material and lined with not less than 26 ga galvanized perforated steel. Filler and facing material shall meet requirements of NFPA 90A with flame spread rating of 25 or less, and smoke development rating of 50 or less.

E. Covering Materials:

1. Covering material shall be polymer film.
2. Provide spacers between covering material and perforated metal.

F. Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.

G. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

2.11 LOUVERS

A. Blank-off panels on unused portion of louver shall be 2" thick insulated panels fabricated of minimum 22 ga galvanized steel on both surfaces. Insulation to be rigid type with minimum R value of 10. Panels shall be reinforced with minimum 20 ga steel stiffeners.

2.12 BIRD AND INSECT SCREENS

A. Bird screens shall be 1/2" square mesh formed with 0.063" diameter aluminum wire. Insect screen to be 18 x 16 with 0.017" diameter aluminum mesh.

B. Frame shall be removable type of minimum 12 ga, extruded aluminum.

2.13 INSTRUMENT TEST HOLES

A. Manufacturers: Ventlok 699 (up to 1" insulation thickness) or Ventlok 699-2 (over 1" insulation thickness), or equivalent as manufactured by DuroDyne or Weicco.

B. Use concave gaskets for round ductwork.

PART 3 - EXECUTION

3.1 MANUAL BALANCING DAMPERS

A. Install manual balancing dampers in all branch ducts of supply, return and exhaust ductwork, as indicated on drawings and as required to regulate airflow to meet air balance requirements. Any manual dampers that are added to the system shall be brought to the attention of the Designer and documented in the as-built documents.

B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.

C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

D. Balancing dampers are not required for supply ductwork upstream of air terminal devices.

E. Balancing damper is not required where terminal air device serves a single diffuser or grille.

3.2 BACKDRAFT DAMPERS

A. Install backdraft dampers where indicated on drawings.

B. Where motorized dampers are shown in exhaust fan discharge duct, or in duct connecting to relief or exhaust louver, backdraft dampers are not required unless specifically indicated. Where motorized dampers are not shown, provide backdraft dampers in these locations.

3.3 FIRE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers where shown on drawings in accordance with manufacturer's installation instructions. Install dampers complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors. Install duct access door at each damper with door size large enough to permit replacement of fusible links and resetting of dampers.

B. Manually test each damper for proper operation by removing fusible link or actuating EFL. Repair or replace any damper that does not close completely. Replace fusible link and certify in writing that each damper was installed according to manufacturer's installation instructions and that each damper can be expected to close completely when fusible link melts.

C. Provide letter from manufacturer's representative indicating that dampers are installed per manufacturer's installation instructions.

D. Demonstrate proper operation of dampers after system is installed and ready for operation.

3.4 CONTROL DAMPERS

A. Install dampers in locations indicated on drawings, as detailed and according to manufacturer's instructions.

B. Install blank-off plates or transitions as specified in Control Sections.

C. Provide adequate operating clearance and access to operators.

3.5 SMOKE DAMPERS AND DETECTORS

A. Install smoke dampers in locations indicated on drawings. Allow room for operator installation and access to operator. Install access door in ductwork for access to damper. When damper is installed in location other than in smoke or fire rated wall, use SMACNA seal class A for ductwork between smoke damper and smoke rated wall for affected zone.

B. Smoke detectors shall be provided by Division 28 Contractor in locations indicated on drawings. Install access door in ductwork for access to detector sampling device.

3.6 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Install remote operated volume control dampers and remote operators as indicated on drawings.

B. Install connecting cable above the ceiling and/or in the wall to locations indicated on the drawings. Cable runs shall be gentle and smooth, with a maximum bend radius of 3’-0”.

C. Install remote operated volume control kit within 18” of the ceiling plane so that it is accessible above the ceiling.

D. Group multiple remote operated volume control kits together at locations indicated on the drawings. Install control kits in organized fashion, use system manufacturer’s multiple port balancing station(s) where appropriate.

E. Clearly label associated damper at control kit adjustment location. Provide laminated annotated plans or diagrams to clarify associated dampers and controller labels.

F. Install cable and sheathing within EMT Conduit. Conduit bend radius shall be 3’-0” minimum. Nearby cables may be grouped into single conduit based on the following:

EMT Conduit Size	Maximum Control Cable Quantity
1/2”	3
3/4”	6

G. Terminate EMT Conduit at within 4’-0” of control kit operator at one end and within 4’-0” of the damper at the other end.

3.7 ACCESS DOORS

A. Install access doors as specified, as indicated on drawings, and anywhere that provision for maintenance, service, cleaning or examination is required, including each automatic damper, fire damper, smoke damper, smoke detector, fan bearing, heating and cooling coil, reheat coils, humidifier, sound attenuating device, filter, valve and control device within duct or casing and at outside air intake duct/plenum.

B. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

Rectangular Duct Size	Minimum Access Door Quantity and Size
10” and smaller	(1) 8” x 8”
12” - 15” and smaller	(1) 10” x 10”
16” - 21”	(1) 14” x 14”
22” - 27”	(1) 18” x 18”
28" - 55"	(1) 24" x 24"
56" - 96"	(2) 24" x 24"

Round Duct Size	Minimum Access Door Size
10" and smaller	8" x 6"
15" and smaller	12" x 8"
29" and smaller	16" x 12"
30" and over	24" x 18"

C. Increase duct size to accommodate access door size indicated above where required.

3.8 TURNING VANES

A. Install turning vanes as shown on drawings and for rectangular square throat elbows unless otherwise indicated. Install turning vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.

B. Install turning vanes so that they are tangent to airflow direction.

3.9 DUCT FLEXIBLE CONNECTIONS

A. Install duct flexible connections for connections that are directly connected to equipment casing containing rotating devices such as fans. Installed width shall be suitable for specific application but shall not be less than 4". Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection.

B. Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection so that duct and opening nearly coincide and are almost equally spaced 3” from one another all around. Do not install flexible connection until above requirements are met. Fans or fan casings and ducts shall be able to move 1” in any direction relative to each other without short-circuiting, metal to metal or stretching taut the flexible connection.

3.10 SOUND ATTENUATING DEVICES

A. Install sound attenuating devices as indicated on drawings and/or as scheduled.

B. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners in accordance with manufacturer's recommendations for multiple unit installation.

3.11 LOUVERS

A. Provide insulated metal panel on unused portion of louver.

3.12 BIRD AND INSECT SCREENS

A. Provide bird screens at louvers and at intake/exhaust openings.

B. Unless otherwise indicated, provide bird screens where filters are specified and insect screens where filters are not specified.

3.13 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.

B. Provide instrument test holes at all ducts insulated with Type R insulation, as directed by TAB personnel, Designer or as shown on drawings.

END OF SECTION 233314

SECTION 233400 - FANS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Fan curves
5. Materials of construction
6. Sound power levels
7. Fan type, size, class, drive arrangement, discharge/rotation, bearings, drives
8. Wheel type, diameter, rpm, tip speed
9. Required fan horsepower including drive losses
10. Motor data (refer to Package A - Section 230513)
11. Vibration isolators furnished with fans
12. Dimensions and weights
13. Special coatings where applicable
14. Color selection charts where applicable
15. Manufacturer's installation instructions
16. All other appropriate data

B. Fan curves shall include series of curves indicating relationship of flow rate (cfm) to static or total pressure for various fan speeds, brake horsepower curves, and selection range (surge curves, maximum rpm, etc.)

C. Indicate performance data, based on both design air quantity and 110% of design air quantity.

D. For variable air volume application, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves.

E. Complete equipment data sheet attached at end of this Section for each piece of equipment and submit with shop drawings. Shop drawings will be returned without review if data sheets are not provided for each piece of equipment and if data sheet is not filled out completely.

1.2 DESIGN CRITERIA

A. Fan ratings shall be tested and certified in accordance with AMCA Standards 210, 211, 300, and 311 and fans shall bear AMCA Seal.

B. Fans shall be furnished complete with motors, wheels, drive assemblies, bearings and accessories as hereinafter specified. Motors for belt drives shall be furnished with NEMA rated adjustable rails or bases.

C. Each fan wheel shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. Complete fan assembly shall be factory balanced statically and dynamically in accordance with Standard AMCA 204-96 for Balance Quality and Vibration Levels for Fans and meet or exceed guidelines in Application Category BV-3.

D. For fans furnished with 5 HP or larger HP motors, each fan assembly shall have factory run test including vibration signatures taken on each bearing in horizontal, vertical and axial direction. Filter-in reading as measured at fan, scheduled rpm shall not exceed the following values when fan is rigidly mounted.

1. Belt Drive 0.15 in/sec peak velocity
2. Direct Drive 0.08 in/sec peak velocity
3. Written records of run test and vibration test shall be available upon request.

E. Furnish fans specified with V-belt drives with fixed-pitch sheaves. Select sheaves to drive fan at a maximum rim speed between 6000 and 6500 FPM.

F. When fixed-pitch sheaves are furnished, system air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. This Contractor shall provide necessary trial and final sheaves and drive belts as required by TAB Contractor.

G. Select each fan to operate at single stable operating point as predicted by fan curve. Fans having 2 potential operating points on fan curves are not acceptable.

H. Unless otherwise indicated, belt drives shall be selected for 150% of motor nameplate horsepower. Fans serving critical exhaust systems (i.e., fume exhaust) shall have a minimum of 2 belts.

I. Provide OSHA compliant belt and shaft guards for belt driven fans in indoor applications. Provide OSHA compliant motor covers for belt driven fans in outdoor applications. Provide speed test openings at shaft locations. Paint belt guards bright yellow.

J. Sound power levels shall be based on tests performed in accordance with AMCA Standards 300 and 301.

K. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. Motor furnished with fan shall not operate into motor service factor in any of these cases.

L. Consider drive efficiency in motor selection according to manufacturer's published recommendation, or according to AMCA Publication 203, Appendix L.

M. For fans furnished with 1 HP or larger HP motors, each fan shaft shall be 1-1/8” diameter minimum.

N. Where inlet and outlet ductwork at any fan is changed from that shown on drawings, submit scaled layout of change and system effect factor calculations indicating increased static pressure requirements as described in AMCA Publication 201. This Contractor shall be responsible for costs associated with any motor, drive, and/or wiring changes required as a result of duct configuration changes at fan.

O. Unless otherwise scheduled, AMCA Type C spark resistant construction per AMCA 99 shall be used for fans handling flammable or grease laden vapors. Fans handling grease laden vapors shall also be provided with a readily accessible grease receptacle not more than 1 gallon capacity. Motors shall be located outside airstream and with all belts and pulleys protected by grease tight housing. Fan assembly shall be UL listed (UL 762) for use with grease laden vapors.

PART 2 - PRODUCTS

2.1 IN LINE DUCT FANS

A. Manufacturers: Twin City, Greenheck, or Cook

B. Fan housing shall be designed for installation in straight run of duct with transitions as indicated. Housing shall be designed for complete access to fan and motor without removing fan assembly from ductwork.

C. Wheel:

1. Single thickness, constructed of aluminum
2. Statically and dynamically balanced in accordance to AMCA Standard 204-05
3. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

D. Motor:

1. Electronically Commutated Motor

a. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
b. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor or integrated variable frequency drive.
c. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
d. Motors can achieve up to 95% efficiency, model and horsepower dependent.

E. Housing/Cabinet Construction:

1. Construction material: Galvanized
2. Square design constructed of heavy gauge galvanized steel

F. Finish:

1. Coating: Electrostatically powder coated

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings, and according to manufacturer's installation instructions. On units provided with drain connection, install drain valve and cap discharge of drain.

B. Perform field mechanical balancing, if necessary, to meet vibration tolerance specified in Division 23 Section Vibration Isolation.

C. Verify lubrication of motor and fan bearings and lubricate in accordance with manufacturer’s recommendations and as specified in Div 23 Section General Mechanical Requirements, Part 3, under lubrication.

END OF SECTION 233400

FAN DATA SHEET

General	Identification	
	Service	
	Location	
	Type	
	Manufacturer & Model Number	
Performance	Capacity	
	Efficiency (%)	
	Brake Horsepower at design flow rate (cfm)	
	Brake Horsepower at 110% of design flow rate (cfm)	
	Capacity	
Physical Characteristics	Size	
	Class	
	Drive Arrangement	
	Discharge Rotation	
	Drive	
	Bearing	
Motor	Manufacturer	
	Horsepower	
	Voltage	
	Phase	
	Hertz	
	RPM	
	Type	
	Enclosure Type	
	Frame Type	
	Insulation Class	
	NEMA Design Designation	
	Service Factor	
	Nominal Efficiency	
	Nominal Power Factor	
	Full Load Amps	
	Variable Frequency Drive Driven (Yes or No)	
Misc	Vibration Isolators	
	Special Coating (Yes or No)	
	Special Coating Type	

SECTION 233600 - AIR TERMINAL DEVICES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Sound rating data
6. Dimensions
7. All other appropriate data

1.2 DESIGN CRITERIA

A. Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below.

B. When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.

C. Unless otherwise stated, units shall be system pressure independent and maintain air volume within ± 5% of required airflow regardless of system air pressure.

D. Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 22 gauge.

E. Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage. Seal joints and seams not factory sealed in field as specified in Part 3.

F. Unit performance shall be certified in accordance with ARI Standard 880 including sound rating data certified for both casing discharge and radiated sound levels from 125 through 4000 Hz.

G. Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.

1.3 CONTROLS COORDINATION

A. Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Controls Contractor's use.

B. Furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by unit manufacturer for unit manufacturer's factory mounting. Coordinate for proper factory installation.

C. Unit manufacturer shall factory install devices to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices with units being provided.

D. Unit manufacturer shall perform preliminary calibration based on scheduled airflow rates.

E. Controls Contractor shall be responsible for calibrating actuators and controllers through TAB work for scheduled airflow rates.

PART 2 - PRODUCTS

2.1 SINGLE DUCT AIR TERMINAL UNITS (Blade Damper type)

A. Air Terminal Devices

1. Manufacturers: Price, Titus, Krueger, JCI, Nailor, Tuttle & Bailey or Metal*Aire similar to Price SDV.
2. Units shall be suitable for direct digital control system. Contractor shall be responsible for wiring from control panels to each terminal unit.
3. Units shall be capable of modulating to full closed position with maximum leakage of 1%.
4. Furnish units with reheat coils having capacities as indicated in schedules.
5. Where reheat coils are scheduled as electric reheat coils, provide the following:
   a. Heating elements shall be open wire nickel chrome construction, supported by ceramic insulators.
   b. Integral control panel with hinged access door for access to all controls and safety devices.
   c. Silicon controlled rectifier (SCR) controller
   d. Minimum capacity shall be 0.5kW, maximum capacity shall meet or exceed values indicated in schedules.
6. Provide access doors for all air terminal devices with reheat coils at inlet side of coils. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units. Access doors shall utilize quarter-turn sash latches and shall be installed on the bottom of the unit.
7. Controller shall be field convertible for direct or reverse acting without recalibration.
8. Unit shall incorporate multi-point, center averaging velocity sensor. Sensor shall provide signal measurable by controller at inlet velocities of 500 fpm. Sensor shall provide control signal accuracy of ±5%, with the same size inlet duct at any inlet condition.
9. Provide supply air units with thermal insulation internally lined with minimum 1” thick matte faced insulation. Insulation shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), UL 723 (Flame & Smoke), ASTM C665 (Fungi Resistance) and ASTM E84 (Flame & Smoke). Provide solid sheet, galvanized inner liner extending over the fiberglass insulation, as well as covering the liner cut edges so that no insulation is exposed to the supply air stream.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings and according to manufacturer's instructions.

B. Install units with sufficient service space to unit control, actuators and access panels.

C. Seal joints and seams of units not factory sealed to meet allowable leakage rate specified for low pressure ductwork.

D. Connect terminal devices to ductwork with removable type joints.

E. Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet for Blade Damper type devices.

F. Provide access panels compatible with ceiling for all units located above non-accessible ceilings.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Sound ratings
6. Dimensions
7. Finish
8. Color selection charts where applicable
9. Manufacturer's installation instructions
10. All other appropriate data

1.2 DESIGN CRITERIA

A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70 and Air Diffusion Council (ADC) Test Code 1062.

B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Price, Titus, Krueger, Nailor, Carnes, Tuttle & Bailey or Metal*Aire.

B. Acceptable manufacturers for specialty products are listed under each item.

2.2 ARCHITECTURAL SQUARE PANEL (PLAQUE) CEILING DIFFUSERS

A. Diffusers shall have one piece 18 ga face panels. Face panel shall be removable by means of four positive locking posts. Exposed surface of face panel shall be smooth, flat, and free of visible fasteners and have rounded off corners. Face panel shall project no more than 3/8” below outside border of diffuser back pan. Back of face panel shall have an aerodynamically shaped, roller edge to ensure tight horizontal discharge pattern.

B. Ceiling diffusers with 24” x 24” full face shall have no less than 18” x 18” face panel size.

C. Back pan shall be one-piece die-stamped and shall include integrally drawn round inlet. Diffuser back pan shall be constructed of 22 ga steel. Diffuser neck shall have minimum of 1-1/4” depth available of duct connection. Back pan shape with face panel shall deliver 360° radial horizontal air pattern.

D. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, diffusers shall have baked enamel or powder coat finish with color selected by Designer.

2.3 LOUVERED FACE CEILING DIFFUSERS

A. Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, with inner core assembly consisting of fixed louvers capable of producing the airflow discharge pattern as indicated on the project plans. Furnish with frame type appropriate to installation and with equalizing grids where it is not possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked white enamel finish.

2.4 CEILING AND WALL MOUNTED REGISTERS AND GRILLES

A. Registers and grilles shall be aluminum or steel as scheduled unless otherwise indicated and furnished with frame type appropriate to installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Return, exhaust, and transfer registers and grilles shall have fixed blade core.

D. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Designer.

2.5 ADJUSTABLE LINEAR DIFFUSERS

A. Linear diffusers shall be extruded aluminum and furnished with frame type appropriate to installation with diffuser elements being removable from frame. Diffuser vanes shall provide both air pattern and flow rate adjustment with air pattern having full 180° adjustment. Diffuser vanes of single slot shall be segmented on 2 or 3 foot centers.

B. Diffuser models, lengths and slot sizes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, frame face shall have baked enamel finish with color selected by Designer. Diffuser vanes and frame interior shall be finished in flat black.

2.6 FIXED BLADE LINEAR DIFFUSERS AND GRILLES

A. Linear diffusers and grilles to be extruded aluminum with frame type appropriate to sidewall, sill or ceiling installation as indicated.

B. Diffuser and grille models, lengths, blade spacing and blankoff strips to be as shown on drawings and/or as scheduled.

C. Diffusers used for supply air to be furnished with straightening or equalizing vanes. Blades to be fixed at 0 or 15° deflection as scheduled.

D. Unless otherwise indicated, diffusers and grilles shall have anodized aluminum finish with color selected by Designer.

2.7 WIRE MESH GRILLES

A. Grilles shall be 2 X 2 mesh (1/2") galvanized steel or aluminum hardware cloth in spot welded galvanized steel frame with 1-1/2" width.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes.

C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.

D. Blank off unused portion of linear diffusers and grilles.

E. Adjust pattern controller for linear diffusers to direct airflow as indicated on drawings.

F. Unless otherwise indicated, provide wire mesh screen at end of each open ended duct (OED).

G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

H. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to final acceptance.

END OF SECTION 233713

SECTION 238129 - VARIABLE REFRIGERANT FLOW SYSTEM EQUIPMENT

PART 1 - GENERAL

1.1 DESIGN CRITERIA

A. A variable capacity, variable refrigerant flow type split system shall consist of multiple evaporators, connected to a single condenser unit or multiple condenser units. The condenser shall be direct expansion (DX), air-cooled, multi-zone split air-conditioning system, with inverter driven variable speed compressor(s), using R-410A refrigerant. All indoor units are each capable of operating separately with individual temperature control.

B. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, a central controller and BACnet integration with BAS. The manufacturer shall provide all necessary gateway and interface with BAS.

C. Furnish unit complete with all components, accessories, and operating and safety controls to provide the intended performance as specified in this Section, as shown on drawings and/or as scheduled.

D. Manufacturer shall be fully responsible in sizing all refrigerant piping related to the system, coordinating pipe distribution, equipment placement, and full coordination with the mechanical and other trade contractors.

E. Ensure that the manufacturer and certified installer complete a system design review prior to any submittals. Size all refrigerant lines. Confirm proper sizing of equipment based on design conditions and loads on equipment schedules. Certify that layout meets code, and the comfort conditions outlined on schedule. Identify any other issues that might affect system layout, operation and design prior to submitting equipment.

F. Insulation and liners shall be provided for all unit cabinets and shall meet NFPA-90A requirements, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.

G. Units shall be UL listed and carry UL Label.

H. Coils shall be rated in accordance with ARI Standards.

I. Each fan and motor combination shall be capable of meeting the following condition while maintaining stable fan performance:
   1. Unit static pressure shall take into consideration actual static pressure loss of components furnished within unit.

1.2 SUBMITTALS

A. Shop drawings including, but not limited to, the following:
   1. Manufacturer's name and model number.
   2. Identification as referenced in the documents.
   3. Capacities/ratings/efficiencies.
   4. Materials of construction.
   5. Filters; size, efficiency.
   6. Fans, type, drives.
   7. Motor data (refer to Section 20 0513 - Motors).
   8. Power and control wiring diagrams.
   9. Vibration isolation furnished with units.
   10. Dimensions and weights.

11. Manufacturer's installation instructions.
12. All other appropriate data.

B. Fan curves to include a series of curves indicating relationship of CFM and static pressure for various RPM and brake horsepower curves. Indicate design-operating point clearly on fan curves.

C. Submit confirmation of the maximum refrigerant volume for each system, including both factory and field charge of R-410a. Motorized isolation valves may not be used for the purpose of reducing the calculated maximum concentration.

D. Submit vibration isolation schedule showing compliance with isolation required in Section 23 0550 - Vibration Isolation.

E. Submit a complete controls architecture drawing showing both the number and location of all equipment. Submit a wiring diagrams, and sequence of operations for each system.

F. Submit a complete condensing unit, indoor unit and branch selector box/branch circuit controller grouping and zoning layout.

G. Submit certification signed by a manufacturer’s representative that proposed installer is a certified, factory trained installer for the proposed systems and units

H. Submit certification that the design and the submittals have been reviewed by a certified factory representative for completeness and accuracy.

I. Submit graphics, trends, and alarms to the Owner for approval.

J. Refer to commissioning specifications for other requirements.

1.3 OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide for services of factory trained service engineer to supervise and approve installation; start-up, test and adjust unit for proper operation; and instruct Owner's representative in operation and maintenance of machine. This shall include furnishing start-up and test log showing all initial settings and readings; signed by manufacturer's service representative. Before acceptance by Owner, unit manufacturer shall approve, in writing, complete installation including piping and wiring connections, and proper functioning of all operational and safety controls.

B. Manuals shall indicate unit model numbers, serial numbers, sizes, type, and indicate name and address of the service company.

C. Description of maintenance required weekly, monthly, quarterly, semi-annually and annually shall be included along with recommended lubrication type.

D. Manufacturer shall include additional 6-year compressor warranty.

1.4 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (ARI) Standard 210 / 240 and bear the ARI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

E. A dry air holding charge shall be provided in the indoor section.

F. System efficiency shall meet or exceed 14 SEER when part of a multi system (2:1/3:1).

G. Manufacturer or manufacturer's representative shall field check, test and start all units after they have been properly installed. Component systems to be run and adjusted to perform quietly and efficiently at capacities scheduled.

H. Manufacturer or a representative shall provide services to field instruct and check unit operation and control of complete system. Instruction shall not take place until HVAC system has been field checked, tested, started and balanced. Manufacturer shall establish instruction dates and give Architect and Owner 10 days written notice of the time. Instructions shall be deemed completed when affidavit of instruction has been signed by representative of manufacturer and Owner.

I. Refer to commissioning specifications for start-up, demonstration and training requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.6 WARRANTY

A. The units shall have a manufacturer's warranty for a period of one (1) year from date of acceptance. The units shall have a limited labor warranty for a period of one (1) year from date of acceptance. The compressors shall have a warranty of six (6) years from date of acceptance. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced by the manufacturer. All warranty service work shall be performed by a factory trained service professional.

1.7 INSTALLATION REQUIREMENTS

A. The system must be installed by a factory trained contractor/dealer. The mechanical contractor's installation price shall be based on the systems installation requirements

1.8 COORDINATION

A. Design and drawings are based on one of acceptable manufacturers listed in this Specification. Where requirements of equipment provided differ from equipment on which design is based, this Contractor shall be responsible for coordinating requirements of equipment with other Contractors involved.

B. This Contractor shall be responsible for any additional cost incurred due to such requirements.

PART 2 - PRODUCTS

2.1 VARIABLE REFRIGERANT FLOW SYSTEM EQUIPMENT

A. Manufacturer: Mitsubishi, Samsung, Daikin, LG or approved equal.

1. Preferred Brand Alternate: Mitsubishi

2.2 CONDENSING UNIT

A. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of compressors, motors, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and liquid receivers.

B. Discharge pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.

C. The connection ratio of indoor units to condensing unit shall be permitted up to 130%.

D. The sound pressure level standard at 3 feet from the front of the unit shall be no higher than 65 dB (A) individually.

E. The condensing unit shall be capable of modular design and should allow for side-by-side installation with minimum spacing.

F. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, fusible plug, overload relay, inverter overload protector, thermal protector for compressor motor, over current protection for the inverter and anti-recycling timer.

G. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

H. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.

I. Unit Cabinet:

1. The condensing unit shall be corrosion resistant. The unit shall be constructed from rust-proofed, mild steel panels coated with a baked enamel finish.

J. Compressor:

1. The scroll compressors shall be variable speed controlled, capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
2. Capacity control range shall be 10% to 100%.
3. Each compressor shall be equipped with a high pressure safety switch, oil protection device and internal thermal overload protector.
4. Oil separators shall be standard with the equipment together with an intelligent oil management system.
5. The compressor shall be spring mounted to avoid the transmission of vibration.

6. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced, ensuring sequential starting of each module at each start/stop cycle or every 8 hours.

K. Electrical:

1. The power supply to the condensing unit shall be as indicated on equipment schedule.

L. Controls:

1. The control voltage between the indoor and condensing unit shall be 24VDC shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring operation.

2.3 DUCTLESS WALL MOUNTED INDOOR UNIT

A. Indoor Unit:

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. Multi-directional drain and refrigerant piping connections.
2. Separate back plate to secure unit to wall.

C. Fan:

1. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.

D. Filter:

1. Return air shall be filtered by removable MERV 6 filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A water-level detection device conforming to UL 508 shall be provided that will shut off the equipment served in the event that the primary drain is blocked. The device shall be installed in the primary drain line, the overflow drain line or in the equipment-supplied drain pan, located at a point higher than the primary drain line connection and below the overflow rim of such pan.
6. Integral condensate pump shall be included to lift condensate when drain connection is below gravity fed drain line.
7. Refrigerant lines to the indoor units shall be insulated.
8. Individual refrigerant pipe isolation valve shall be provided for each unit isolation.

F. Electrical:

1. The unit electrical power shall be as indicated on equipment schedule.

G. Control:

1. The indoor unit shall include an in-room wired wall mounted remote controller with integral temperature sensor, unless otherwise noted on the drawings.
2. The unit shall have a controller to perform input functions necessary to operate the system.
3. The indoor unit shall have controls provided by the manufacturer.
4. The controller shall consist of a Power On/Off switch, Mode Selector, Temperature Setting, Timer Control, Fan Speed Select.
5. The unit shall perform Self-diagnostic Function, Test Run switching and Check Mode switching.
6. Temperature changes shall be by 1ºF increments with a range of 65-87ºF.
7. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from controller, providing emergency operation and controlling the outdoor unit.
8. The indoor units shall be capable of working with multi-zone condensing units.
9. Control system shall provide On/Off and System/Mode functionality.
10. Unit shall come with a full BACnet interface to BAS and shall allow the BAS system to reset set point temperature and fan speed, as well as turn off and on unit. BAS system shall be able to monitor temperature setting, space temperature, alarms, status, mode, and fan speed.

2.4 BRANCH CIRCUIT CONTROLLER

A. General:

1. The units shall be factory assembled, wired, and piped.
2. All Branch Circuit Controllers shall be factory run tested.
3. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
4. The units must be mounted indoors.
5. The units shall house liquid-gas separator and multiple refrigerant control valves as required.
6. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

B. Unit Cabinet:

1. The units shall have a galvanized steel plate casing.
2. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.
3. Each cabinet shall house 5 electronic expansion valves for refrigerant control per branch.
4. The cabinet shall contain one subcooling heat exchanger per branch.
5. The unit shall not require provisions for condensate removal.

C. Refrigerant Valves:

1. The units shall be furnished with appropriate expansion valves for the operation of the system and isolation ball valves for individual refrigerant circuit isolation.

D. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.5 CONTROLS

A. System shall include full BACnet/IP interface to BAS.

B. The Controls Network shall be provided to interface with manufacturer provided remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, and graphical user workstation. The Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, online maintenance support, and integration with the Building Automatic System (BAS) using a BACnet/IP interface.

C. Quantities of control devices are not shown on the drawings. Provide controls equipment required to meet the requirements of the documents.

D. Provide local remote controllers in each zone to ensure local control over temperature.

E. Each VRV system shall be able to maintain independent system setpoints and all functionality. System shall not rely on the server for proper operation.

F. Provide control system that gives all functionality to the Owner for all aspects of the system including set-up, network and unit configuration, access to all points (real and virtual), variables, setup of schedules, trends, alarm, graphics, etc. No parts of the system functionality shall be withheld.

G. All points on the system shall be exposed for interface with the BAS.

H. Final interface with BAS shall be reviewed with the equipment providers, Contractors, Engineers, and the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings and according to manufacturer's instructions.

B. Start-up units in accordance with manufacturer’s start-up instructions. Test controls and demonstrate compliance with requirements.

C. Extend cooling coil condensate drain to nearest code approved drain location; provide trap at drain pan. Provide condensate pump if required and not provided by unit manufacturer.

D. Install vibration isolators and flexible pipe connectors as specified in Section 23 0550 - Vibration Isolation.

E. Install secondary drain pan with integral high-water level shut down switch if units are located above hard ceilings.

F. Provide all necessary connections to units as required to complete installation.

G. Manufacturer and/or manufacturer's representative shall calibrate all of the unit's control devices to insure proper operation of system. Manufacturer shall coordinate with Controls Contractor to insure proper operation of system.

H. Manufacturer and mechanical contractor shall coordinate with other trades to provide necessary services to complete installation and provide a full functional system.

I. Refer to commissioning specifications for demonstration requirements.

3.2 BUILDING AUTOMATION SYSTEM (BAS) INTERFACE:

A. Control system shall communicate all data to a remote integrated DDC processor via BACnet MS/TP or BACnet/IP communication protocols. The data shall include as a minimum all system operating conditions, setpoints, capacity controls, and safety shutdown conditions.

B. Provide all software and hardware, including, but not limited to enclosures, controllers, network controllers, network switches, transformers and all associated wiring as required to interface system controller with Building Automation System.

C. Provide listing of all input/output points including controller IP Address, controller BACnet Network ID, controller BACnet Device ID, controller BACnet Port Number, BACnet Instance Number, point description and associated engineering units for each point, as applicable.

D. Refer to Control Sequences and Control Drawings.

E. Equipment manufacturer/supplier shall be responsible for coordination of all communication requirements with Control Contractor, translation of network protocols, testing of communications between systems, and joint commissioning of systems.

END OF SECTION 238129

SECTION 238214 - HEATING AND COOLING TERMINAL DEVICES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data for all items in this Section including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the documents
3. Capacities/ratings
4. Materials of construction
5. Dimensions and weights
6. Color selection chart where applicable
7. Wiring diagrams
8. Motor data
9. All other appropriate data

1.2 REFERENCE STANDARDS AND DESIGN CRITERIA

A. Units including electrical work shall be UL listed.

PART 2 - PRODUCTS

2.1 DUCT REHEAT COILS (HOT WATER)

A. Tubes: Copper, Copper, 1/2 or 5/8 inch O.D., 0.016-inch wall thickness minimum.

B. Fin Thickness: Aluminum, 0.0045-inch minimum.

C. Fin Spacing: 10 per inch maximum for standard coils, 12 per inch maximum for high capacity coils.

D. Coils shall be suitable for minimum working pressure to 200 psig and temperatures to 200°F.

E. Coils having steel nipples for connection are not allowed.

F. Coil fins shall be continuous serpentine or plate fin type.

G. Coil headers shall be cast iron with tubes expanded into headers or heavy seamless copper with all tubes brazed to header.

H. Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

I. Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.2 FAN COIL UNITS

A. Manufacturers: Enviro-Tec, JCI, Titus, Greenheck, Carrier, Trane, or Daikin.

B. Unit data shall be certified in accordance with AHRI Standard 430 or 440.

C. Units shall be furnished with 18 ga steel cabinet and access to all internal mechanical and electrical devices. Cabinets of exposed units shall have baked enamel finish in one of manufacturer's standard colors, selected by Architect. Cabinets of concealed units may be prime coated or galvanized steel. Ducted units shall be furnished with supply and return duct collars.

D. Units shall be acoustically and thermally insulated with minimum 1/2" glass fiber insulation.

E. Units shall be furnished with centrifugal fans, separate hot and chilled water coils as scheduled, speed selection switches, condensate drain pans, galvanized steel casings and electrically commutated (EC) motors.

F. Coils shall be constructed of seamless copper tubes with aluminum fins suitable for minimum working pressure to 300 psig and temperatures to 200°F. Furnish coils with manual air vents.

G. Fan wheels shall be steel or aluminum construction, centrifugal forward-curved and double-width type, statically and dynamically balanced.

H. Electronically Commutated Motor

1. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
2. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor or integrated variable frequency drive.
3. Motor shall be speed controllable down to 20% of full speed (80% turndown). Motor shall be factory configured for 3 speed operation and capable of accepting 0-10 VDC signal from BAS.
4. Motors can achieve up to 95% efficiency, model and horsepower dependent.

I. Drain Pans

1. Drain pans shall be constructed of galvanized steel or plastic lined with 1/2" fire retardant closed cell foam. Drain pan material and insulation shall meet requirements of ASTM E84 or UL 723.
2. Furnish drain pan with secondary drain connection located at higher level than primary drain connection for condensate overflow.
3. Furnish drain pan with condensate overflow switch conforming to UL 508 for condensate overflow unit fan shut off. Locate switch just below secondary drain connection. Pipe secondary drain to primary drain line before p-trap.
4. Provide condensate pump when evaporator drain connection is below gravity fed drain line. It shall have capacity of 151 gph at 9 feet head. It shall be complete with integral float switch, pump and motor assembly and reservoir. Electrical power shall be 120 V, 1-phase, 60 Hz.

J. Each unit shall include readily accessible filter rack. Furnish 2 sets of filters as scheduled for each unit.

K. Provide unit mounted combination starter/non-fused disconnect switch.

2.3 ELECTRIC UNIT HEATERS

A. Manufacturers: Berko, Trane, Electromode, or Singer

B. Heating elements shall be corrosion resistant, installed to prevent noise of expansion and contraction. Units shall be designed for even distribution of air across heating element.

C. Units shall be furnished with necessary over-heat protection, reset devices, contactors, transformers and control as required. Provide adjustable thermostatic control for operation of fan and heater.

D. For units with integral fans, furnish units with fans switches to maintain fan operation until all residual heat in elements has been dissipated.

E. Fans shall be statically and dynamically balanced. Fans and motors shall be mounted for vibration free operation.

F. Cabinets shall be 20 ga steel. Exposed cabinets shall have baked enamel finish in one of manufacturer's standard colors, selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as indicated on drawings, and according to manufacturer's installation instructions.

B. Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

3.2 FAN COIL UNITS

A. Install units as shown on plans and according to manufacturer’s installation instructions. Unit placement shall be coordinated with other utilities to avoid routing of utilities below unit which would interfere with maintenance access.

B. Provide threaded rods with vibration mounts for upper attachment to structure and unistrut for lower attachment to threaded rod for units shown to be installed overhead. Refer to section 230529 – Mechanical Supporting Devices and section 230550 – Vibration Isolation for additional requirements.

C. Provide additional wiring from float switch mounted in overflow drain connection to BAS to signal an alarm whenever moisture is detected in the overflow pipe.

D. Duct connections to fan coil unit shall use flexible duct connections.

END OF SECTION 238214

SECTION 238413 - HUMIDIFICATION EQUIPMENT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:

1. Manufacturer's name and model number
2. Identification as referenced in the Documents
3. Capacities/ratings
4. Materials of construction
5. Absorption distances
6. Dimensions
7. Electrical data and wiring diagrams including power, signal and control wiring for electric type humidifiers
8. Manufacturer’s installation instructions
9. All other appropriate data

PART 2 - PRODUCTS

2.1 ELECTRIC STEAM GENERATORS

A. Manufacturers: DriSteem, Condair, or Carel.

B. Unit shall be self-contained, electric steam generating humidification system. Steam shall be generated by boiling off non-potable water from building supply.

C. Unit shall be completely pre-wired and include built-in transformer to provide 24V supply for control circuit.

D. Provide fused disconnect switch

E. Cabinet Construction:

1. Constructed of powder coated steel.
2. Designed and secured to prevent accidental contact with electrical components. The front exterior of the cabinet shall contain the controller’s touch keypad.
3. Steam cylinder and electrical compartments shall have removable doors with door interlock safety switch to interrupt unit operation when doors are open or removed. Door interlock switch can be overridden to allow for troubleshooting.

F. Electrode Steam Generation Cylinder:

1. Disposable plastic cylinder with welded seams.
2. Integral high-water sensor probe.
3. Steam outlet on top of cylinder for connection to duct-mounted dispersion tube assembly.
4. Provide 98% thermal efficiency for entire cylinder life.

G. Steam cylinder compartment shall have reusable, spring loaded brass electrode plugs to ensure safe, secure connection of primary voltage leads to the steam cylinder for life of unit.

H. Unit shall include internal drain water tempering to ensure maximum 140°F drain water.

I. Unit shall be capable of modulating output between 20% to 100% of rated capacity.

J. Controls:

1. Integral microprocessor controller shall be factory-mounted and wired. The following features and functions shall be provided:

   a. LED "heartbeat" fault indicator. Performs software self diagnosis at every start-up.
   b. Water make-up valve control and low-water safety shut down.
   c. Full cylinder indication and pre-notification of end of cylinder life.
   d. Auto drain/refill sequence to maximize cylinder life and reduce water usage.
   e. Auto off-season shut-down to completely drain cylinder after no humidification demand for 72 hours (adjustable) and automatically restart on call for humidity.
   f. Four-position functional slide switch on microprocessor board, "AUTO", "STANDBY", "DRAIN", "TEST".
   g. Airflow proving switch.
   h. A compatible humidity sensor shall be shipped loose for field installation in return duct.
   i. A 2 position high limit humidistat shall be shipped loose for field installation. Humidistat shall sense humidity level within supply duct and protect against saturation of air stream.

2. Furnish BACnet/MSTP interface software and hardware to BAS for reporting status, alarms (including cylinder replacement notification), RH sensor, and other monitoring points plus adjustable setpoints.

K. Furnish fill cup extension kit as required to accommodate associated dispersion unit.

L. Furnish manufacturer’s distribution and condensate hoses when distance between steam generator and humidifier dispersion unit is within manufacturer’s recommended allowances.

2.2 HUMIDIFIER DISPERSION UNITS

A. Manufacturers: DriSteem, Condair, or Carel.

B. Steam dispersion unit similar to DriSteem Ultra-Sorb LV

C. Factory-assembled steam dispersion unit shall include the following components:

1. Steam supply header/separator
2. Condensate collection header
3. Steam dispersion tubes spanning distance between 2 headers

D. Each dispersion tube shall be fitted with steam discharge tubelets inserted into tube wall. Each tubelet shall be made of thermal-resin material designed for high steam temperatures. Two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow.

E. Each tubelet shall extend through wall of and into center of dispersion tube and contain steam orifice sized for its required steam capacity.

F. Each packaged humidifier panel assembly of tubes and headers shall be contained within galvanized metal casing to allow convenient duct mounting, or to facilitate stacking of and/or end-to-end mounting of multiple humidifier panels in ducts or air handling unit casings.

G. Tubes, headers and mounting frame shall be 304 stainless steel and be Heli-arc welded.

H. Tubes and headers shall be factory insulated.

2.3 AFTERCOOLERS

A. Manufacturers: DriSteem, Penn Separator or approved equal. Units shall be similar to DriSteem Drane Kooler.

B. After coolers shall be constructed of 304 stainless steel and furnished with inlet, vent and drain connections and stainless steel striking plate.

C. Furnish unit complete with floor supports, strainer and thermostatically controlled water regulator valve to temper 212°F condensate water to discharge 140°F water to sanitary drain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as indicated on plans, details, and according to unit manufacturer's instructions.

B. Install make-up water and drain lines. Coordinate with Plumbing Contractor.

3.2 STEAM HUMIDIFIERS

A. Mount units in ductwork as indicated on drawings. Provide additional support for humidifier body or distribution manifolds as recommended by manufacturer.

B. Install steam and condensate branch lines with minimum in accordance with manufacturer's recommendations. When metallic tubing is used, ream pipe and blow out at full steam pressure before connection to humidifier.

C. Furnish aftercooler for condensate tempering and route to nearest code approved drain.

END OF SECTION 238413

SECTION 260000 - GENERAL ELECTRICAL 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 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 contract documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install"
2. "Furnish" or "furnished" does not include installation
3. "Install" or "installed" does not include furnishing

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

G. Where architectural features govern location of work, refer to architectural drawings.

H. Work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

I. Contractor shall furnish all protective current device time-current characteristic curves for each circuit breaker to the engineer in order to prepare the device settings. Contractor shall be responsible for setting all circuit breaker trip units. Contractor is responsible for all arc-flash labels. The engineer will furnish the device settings to the contractor in order to selectively coordinate the emergency branch and the elevator motor over-current protection. The engineer shall perform the short-circuit analysis, coordination study and arc flash analysis.

1.3 RELATED WORK

A. Utility Services:

1. Determine utility connection requirements and include in base bid all costs to Owner for utility service. Coordinate with UNCW electric distribution shop.
2. Contractor shall be responsible for all costs associated with utility work for new electrical service(s) to the building.

3. Coordinate directly with UNCW for Medium Voltage utility service work within Owner's electrical manholes and tie-in to medium voltage switch.

B. Continuity of Service:

1. No service shall be interrupted or changed without permission from the Designer and Owner. Obtain written permission before work is started.
2. When interruption of services is required, all persons concerned shall be notified at least 5 working days in advance and shall agree upon a time.

C. Demolition:

1. Perform demolition as required to accomplish new work.
   a. Remove abandoned wiring and conduit to source of supply, unless noted otherwise.
   b. Remove exposed abandoned conduit, including abandoned conduit routed below grade that is being demolished due to the work.
2. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other contractors.
3. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
4. Equipment noted to be removed and turned over to Owner shall be delivered to Owner at place and time Owner designates.
5. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
6. Where demolition work interferes with Owner's use of premises, schedule work through Designer and Owner. Designer must approve schedule before Contractor begins such work.

D. Concrete Work:

1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of electrical equipment.
4. Concrete work for outdoor equipment shall be coordinated to accommodate conduit stub-up(s) and equipment grounding. Contractor shall coordinate this effort prior to the work.
5. Provide housekeeping pads for equipment as shown on the drawings. Housekeeping pads shall be provided for all floor-mounted equipment. Note that pad size and window locations shall be provided upon review of approved equipment manufacturer's product date.
6. Provide 1" non-shrink grout pad under steel support structure legs for equipment, conduits, etc. that are to be secured to the floor.

E. Painting:

1. Painting of electrical equipment will be done under Division 09 unless specified otherwise or is to be furnished with factory applied finish coats.
2. Furnish equipment with factory applied prime finish unless otherwise specified.
3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Designer.
4. Furnish one (1) can of touch up paint for each factory finish, which will be final finished surface of product.
5. Paint exposed threads of metal conduits routed in exterior locations above grade. Paint shall be manufacturers specifically of this application.
6. Exposed conduit and boxes in finished areas shall be painted to match surroundings. Refer to Division 09.
7. Junction boxes in concealed locations shall be painted to identify systems contained therein. Refer to Section 250553.

F. Coordination Drawings:

1. Refer to Division 01 for coordination drawing requirements.
2. Coordination drawings are required to coordinate work among all trades and to facilitate installation.
3. The coordination drawings will be reviewed for adherence to design intent and potential layout conflicts.

G. Firestopping Penetrations:

H. Refer to Division 07 for firestopping requirements.

I. Requirements of Regulatory Agencies: Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

J. Commissioning:

1. Refer to Division 01 – Commissioning.
2. Selected equipment and systems will be commissioned as part of the project requirements.
3. This contractor shall support commissioning the commissioning process as defined elsewhere within these specifications.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1.	AEIC	Association of Edison Illuminating Companies
2.	ANSI	American National Standards Institute
3.	ASHRAE/IES	(90.1 Energy Code)
4.	ASME	American Society of Mechanical Engineers
5.	ASTM	American Society for Testing and Materials
6.	BICSI	Building Industry Consulting Services International
7.	BOCA	Building Officials Code Administrators
8.	EIA	Electronic Industries Association
9.	FIPS	Federal Information Processing Standards
10.	FCC	Federal Communications Commission
11.	ICEA	Insulated Cable Engineers Association
12.	ICC	International Code Council
13.	ICBO	International Conference of Building Officials
14.	IEEE	Institute of Electrical & Electronics Engineers
15.	IESNA	Illuminating Engineering Society of North America
16.	NCCM	North Carolina Construction Manual
17.	NCSBC	North Carolina State Building Code
18.	NEC	National Electrical Code
19.	NECA	National Electrical Contractors Association
20.	NEIS	National Electrical Installation Standards
21.	NEMA	National Electrical Manufacturers Association
22.	NESC	National Electrical Safety Code
23.	NETA	National Electrical Testing Association
24.	NFPA	National Fire Protection Association
25.	NIST	National Institute of Standards & Technology

26.	OSHA	Occupational Safety and Health Administration
27.	SBCCI	Southern Building Code Congress International
28.	TIA	Telecommunications Industries Association
29.	UL	Underwriters Laboratories, Inc.
30.	STS1000	Telecommunications Wiring Guidelines for the State of North Carolina

B. List for Third Party Agencies Accredited by the NCBCC to Label Electrical and Mechanical Equipment, shall be obtained from Department of Insurance, Electrical Inspection Section.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 LISTING

A. Material installed on project shall bear approved third party label. Refer to List of Third Party Agencies Accredited by the NCBCC to Label Electrical and Mechanical Equipment.

1.7 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 01 for Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout specification.
3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
4. Mark general catalog sheets and drawings to indicate specific items submitted.
5. Include proper identification of equipment by name or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Submittals shall be clearly marked and noted accordingly.
7. When luminaires, equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
8. Include wiring diagrams for electrically powered or controlled equipment.
9. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.

B. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review. It is the contractor's responsibility to verify that submittals are in compliance with the drawings and specifications and by an approved manufacturer. Contractor shall submit a cover letter with each submittal section stating each instance where the submittal does not meet the specifications or how the submittal is different but equal. The submittal must contain all pertinent information as outlined in the specifications for Designer's review. Without this information, Designer may not review submittal and any time delay incurred due to supplemental submittal or resubmittal shall be the burden of the contractor.

C. Certificates and Inspections:

1. Obtain inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.
2. It is the responsibility of the contractor to contact the State Electrical Inspector, Department of Administration, State Construction Office, to schedule all required inspections.
3. Contractor shall notify Designer at least 72 hours prior to energizing any equipment. Designer shall be allowed to inspect complete system (or the complete portion of the system to be energized) prior to contractor energizing equipment. Any punch list items or deficiencies noted during Designer's inspection shall be corrected and Designer shall re-inspect and approve corrections prior to contractor applying power to the equipment. North Carolina Electrical Inspector approval shall NOT be adequate for applying power to equipment unless Designer specifically defers approval of equipment for energization to the NC DOA inspector.

    a. Contractor shall not request inspections of individual pieces of equipment. Inspections shall be for major systems, or major portions of systems such as:

        1) Service Entrance Equipment.
        2) All electrical rooms.
        3) All panelboards and distribution equipment.
        4) Mechanical room distribution equipment.
        5) All mechanical room motors.
        6) Other major groupings of equipment.

D. Operation and Maintenance Manuals:

1. Refer to Division 01 for Closeout Procedures.
2. Upon completion of work but before final acceptance of system, submit to Designer for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
4. Manuals shall include the following:

    a. Copy of complete, approved submittals with Designer's comments.
    b. Copy of the project specifications as provided by Designer.
    c. Copies of shop drawings.
    d. Associated test reports.
    e. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
    f. Phone numbers and addresses of local parts suppliers and service companies
    g. Internet/WEB page addresses where applicable
    h. Wiring diagrams
    i. Start up and shut down procedure
    j. All factory and field test records
    k. Additional information, diagrams or explanations as designated under respective equipment or systems specification section

5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus and will occur prior to beneficial occupancy or final acceptance (whichever comes first).
6. O&M manuals and instructions to Owner shall be provided 6 Months prior to beneficial occupancy or final acceptance (whichever comes first).

E. Record Documents:

1. Refer to General Conditions of Contract, and Division 01 for Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of contract documents as prepared by Designer to mark-up for record drawing purposes.
3. Prepare complete set of record drawings by revising reproducible copies of original contract documents as prepared and furnished by Designer. Where reproducible drawings cannot be satisfactorily revised for record purposes, prepare appropriate new drawings on reproducible sheet material furnished by Designer.
4. Provide complete set of record drawings to Designer for transmission to owner per drawings and specifications.

1.8 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Coordination:

1. Provide power wiring for motors and electrically powered or electrically controlled equipment, as indicated on contract documents. Control wiring shall be provided by Contractor providing equipment being controlled.
2. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
3. Starters in motor control centers, wire, conduit, and other devices required for power to equipment shall be provided by Electrical Contractor except as specifically noted elsewhere in these specifications.
4. All individually mounted starters, VFD's and disconnect switches for mechanical equipment (fans, pumps, etc.) furnished under Division 21, 22 or 23 shall be furnished and installed by contractor supplying motor being controlled, unless the equipment is indicated to be part of a motor control center.
5. Power wiring shall be provided by Division 26 contractor up to a termination point consisting of a starter, VFD or disconnect switch. Under Division 26-line side terminations shall be provided. Wiring from the load side of each termination point to the mechanical equipment, including final connections, shall be provided under Division 21, 22 or 23 as applicable.
6. Wiring from the load side of the individually mounted starter, VFD or disconnecting means to the motor shall be by the contractor providing the motor being controlled. Wiring from the power source to the line side shall be by the E.C. The disconnecting means may be the VFD when the VFD is installed adjacent to the motor. If VFD is remote from the motor and a separate disconnecting means is required, the contractor providing the motor shall provide all wiring and equipment from the VFD to the motor.
7. In the case of individual starters or VFD's, wiring and disconnecting means from output of starter/VFD to motor shall be the responsibility of the contractor providing the motor being controlled (and the starter/VFD).
8. This Contractor's drawings and/or specifications shall show number and HP rating of motors furnished by others, together with their actuating devices. Should any change in size, HP rating or means of control be made to any motor or other electrical equipment after contracts are awarded, Contractor responsible for change shall immediately notify this Contractor and Construction Manager (CMAR). Additional costs due to these changes shall be the responsibility of Contractor initiating the change.
9. Disconnect switches for other equipment furnished under divisions 1-20 shall be provided by the electrical contractor. Wiring, including final connections to equipment, shall be provided by the electrical contractor. Coordinate specific wiring requirements with equipment supplier.

10. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, raintight, explosion proof, dust-tight, or any other special type as required.)
11. Motors shall be furnished by others for starting in accordance with local utility requirements and shall be compatible with starters as specified herein or under various trade sections of these specifications.
12. Equipment less than 110V, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 21, 22 or 23 shall be furnished, installed and wired under Division 21, 22 or 23.
13. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 21, 22 or 23.
14. Roof exhaust fans with built-in disconnects provided under Division 23 shall be wired under Division 26 to the line side of the disconnect switch. A disconnect switch shall be provided under Division 23 if the fan is not provided with a built-in disconnect switch. In this case, wiring from the switch to the fan shall be provided under Division 23.
15. Duct mounted smoke detectors shall be furnished and wired by Division 26 contractor, installed by Division 23 contractor and wired by Division 26 contractor. Fire alarm AHU shut down circuits shall be wired from the appropriate fire alarm relay to a termination point adjacent to the AHU control panel or starter under Division 26. AHU control wiring from the termination point to the equipment shall be under Division 23. Fire alarm AHU shutdown relays shall be installed to interrupt the wiring transmitting the "Start" signal to fans.
16. All low-voltage controls transformers shall be furnished with a disconnect switch by Division 26.
17. All sprinkler flow and tamper switches shall be furnished and installed under Division 21 and wired under Division 26.
18. Where miscellaneous equipment such as motorized screens, motorized shades, dock levelers, lifts, etc. provided by Contractor requires installation of control switches, control wiring and associated raceways to demonstrate operation of equipment, these shall be provided by the Contractor. Wiring and control switches shall be provided in accordance with equipment manufacturer's recommendations.
19. Where electrical wiring is required by trade other than covered by Division 26, specifications for Division 26 wiring and raceway materials shall apply. No Exceptions.
20. Locations of necessary penetrations must be carefully coordinated with the structural engineer. Contractor shall submit a detailed plan of structural sleeve locations for review by structural engineer.

C. Cutting and Patching:

1. Refer to General Conditions of the Contract, and Division 01 for Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Designer and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:

1. Refer to Division 01 for Closeout Procedures.
2. Periodically as work progresses or as directed by Owner, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.9 GUARANTEE

A. Guarantee for one year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

B. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

C. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Designer and guarantee such restored work to same extent as it was guaranteed under such other contract.

1.10 COMMISSIONING

A. Commissioning requires the participation of this Contractor to ensure all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in the commissioning sections of the specifications. Contractor shall be familiar with all parts of commissioning specification and shall execute all commissioning responsibilities assigned to them.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

3.2 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the site under provisions of Division 1.

B. Store and protect products under provisions of Division 1

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic. Provide plastic wrapping of electronics equipment (not furnished with wrapping) prior to energization.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Designer prior to execution.

E. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 07.

F. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved prior to preparing openings in structural member.

G. Openings for penetrations shall be minimum 1/2" larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

H. Firestop systems shall be those details from the latest version of the UL Fire Resistance Directory equal to those shown on the approved drawings.

I. Where penetrations of fire-rated assemblies are involved, submit manufacturer's UL classified firestopping systems and application details demonstrating compliance with ASTM E-814.

J. Seal non fire-rated floor penetrations with non-shrink grout, or urethane caulk, as appropriate. All wall or ceiling penetrations shall be sealed.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop. Seal annular space between sleeves and pipe with modular wall and casing seals. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts. Verify details.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

M. Provide chrome or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified in those areas.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required, to provide access shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for the purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.

E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL or third party label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.

F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Designer reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify door swings before installing room lighting switch boxes and install boxes on latch side of door unless otherwise noted

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" thick insulation or similar product applied with adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.7 HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for all floor-mounted equipment, outdoor equipment, and as shown on the drawings.

B. Pads shall be 4" high (above grade or finished floor) and be 3" wider and longer than equipment it supports.

C. Refer to the structural drawings for concrete pits underneath service switchgears.

D. Minimum 3000 PSI.

3.8 ACCEPTANCE TESTING

A. Testing shall be performed by qualified persons either engaged by the Contractor or by the Contractor himself. Contractor shall submit qualifications of technician(s) performing testing for approval by Designer and Owner prior to the work. Contractor shall engage manufacturer for start-up of all equipment in accordance with Section 260801.

B. When testing is to be witnessed by Designer or Inspector, notify them at least 10 days prior to testing date.

C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. Make repairs with new materials.

D. This Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

E. Maintain copies of certified tests, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

F. The Contractor shall participate in all commissioning activities. This includes:

1. Scheduling commissioning activities.
2. Hiring component testing companies.
3. Renting testing equipment to include meters and loadbanks.
4. Providing labor to set up testing activities.
5. Other requirements per the specific commissioning specifications.

3.9 ARC FLASH LABELS

A. Contractor shall furnish and install Arc-Flash labels on all electrical equipment.

1. Label shall be Brady B-595.
2. Size of the label shall be 4” x 4” and 4” x 6” for switchgears (2 labels per gear).
3. Label shall be thermal transfer type label of high adhesion for each work location analyzed.
4. Labels shall be machine printed, with no field marking.
5. All electrical equipment described in division 26 shall have an arc flash label.
6. The labels shall be based on current standards: ANSI Z534.4 and 2009 NFPA70E.
7. The label shall include the following information, at a minimum:

    a. Location designation
    b. Nominal voltage
    c. Flash hazard distance
    d. Flash hazard boundary
    e. Hazard risk category
    f. Clothing category
    g. PPE description
    h. Glove class
    i. Incident energy
    j. Working distance (limited, restricted, and prohibited)
    k. Engineering report number, revision number, and issue date.
    l. Logo of UNCW

B. The Engineer will provide a PDF template of each arc flash label to the contractor.

1. The actual label shall match the font and size shown in the PDF template provided by the Engineer.
2. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the Owner and after any system changes, upgrades or modifications have been incorporated in the system.
3. All labels shall be installed in a clean and dry surface of the equipment designated by the Owner. Labels shall be installed according to the recommendations of Brady.
4. Installed warning labels background color will be based upon hazard category and coordinated with the Owner and the Engineer.

C. All text and numbers in the labels shall be readable in both indoor and outdoor environments for at least 5 years.

D. Engineer and Owner reserves the right to reject any of the labels and the Contractor shall provide new labels.

E. Contractor to provide 10% of the total number of arc flash labels as spare labels. These spare labels will be used for modifications of the electrical equipment that may occur during construction, due to change orders or field directives.

3.10 START-UP

A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.11 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from power distribution equipment enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.

D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

3.12 ATTIC STOCK

A. Conventional Lighting Control Devices

1. Base bid: No attic stock
2. Alternate Bid No. 45 - Provide 5% spare owner-stock for each device type rounded to the nearest whole carton with a minimum of one.

   a. Newly fabricated replacement parts shall be physically, electrically, and functionally compatible.

B. Lighting

1. Base bid: No attic stock

2. Alternate Bid No. 46 - Contractor shall provide all spare optical accessories specified (or as noted in submittals) to be labeled to conform to approved product data. Note that manufacturer accessory ordering nomenclature for items shipped loose rarely coincides with fixture ordering matrix. All items need to be identified to replicate conditions.

   a. Spare Parts – Provide a minimum of 1 and maximum of 36 for all components below:

      1) Provide 3% of installed globes and guards.
      2) Provide 3% of installed louvers and reflector cones.
      3) Provide 3% of installed plastic diffusers and lenses.
      4) Provide 3% of installed drivers, power supplies, and transformers for each type and rating installed.
      5) Provide 3% of installed replaceable LED modules for each module type installed.
      6) Manufacturer and model number shall match those installed in the project's luminaires.
      7) Provide 1% spare LED luminaires with non-replaceable modules consisting of entire LED luminaire assembly and driver(s).

   b. Spare components shall be delivered to Owner in new condition and in original packaging.

C. MDS Main Breaker

1. Base bid: No attic stock
2. Alternate Bid No. 47 – Provide one (1) 2000A LSIG main circuit breaker

D. Lighting Control Module

1. Base bid: No attic stock
2. Alternate Bid No. 48 – Provide one (1) lighting control module for occupancy sensor

E. Fire Alarm

1. Base bid: Contractor shall provide to the Owner the following spare parts in quantities shown relative to installed quantity. (required by SCO) Rounded up to the nearest whole device:

   a.

	Quantity	Type of Device Present
1)	10%	Photoelectric smoke detectors
2)	10%	Heat detectors
3)	10%	Smoke and heat detector bases
4)	5%	Isolation Modules
5)	10%	Control Modules
6)	4%	Duct detectors with housing and sample tubes
7)	4%	Speaker/strobe Units
8)	4%	Speakers
9)	4%	Strobes
10)	2%	Manual Pull Stations

2. Alternate Bid No. 49 - Contractor shall include in bid the cost to furnish and install four detection and four annunciation devices per floor beyond that shown on drawings with locations to be determined in the field by the engineer.

3.13 CONSTRUCTION WASTE MANAGEMENT:

A. Construction Waste Management: The Construction Manager at Risk, subcontractors, and their personnel shall follow the procedures and practices for waste separation, collection and transport as defined in the "Construction Waste Management Plan", per Division 01 of these specifications.

END OF SECTION 260000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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 DESCRIPTION

A. This section includes conductors and cables rated 600 volt and less, connectors, splices, and terminations rated 600 volt and less, sleeves and sleeve seals for cables.

B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used. All conductors and cables (both for power, controls, and signals) shall be rated for 600 volts.

C. Connections and terminations shall be made with compression type connectors using solid long barrel two-hole type connectors at terminals and installed with hydraulic compression tool similar to Anderson or Burndy.

D. Each 120V and 277V branch circuit shall have a dedicated neutral conductor.

1.3 REFERENCE STANDARDS

A. NFPA 70

B. UL83 - Thermoplastic - Insulated Wires and Cables

C. UL44 - Rubber-Insulated Wires and Cables

D. UL486A - Wire Connectors and Soldering Lugs for use with Copper Conductors

E. UL4868 - Wire Connectors for use with Aluminum Conductors

F. UL486C - Splicing Wire Connectors

1.4 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Each type of wire used with description of application.
2. Product data sheets containing information to confirm specification compliance.
3. Each circuit type shall use the same type of wiring by the same manufacturer.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.

2. Furnish products listed and classified by Underwriters Laboratories, Inc., or other 3rd party listing having NCBCC approval as suitable for purpose specified and indicated. Products that do not bare UL label or other 3rd party label are not acceptable.

B. Wire and cable boxes and reels shall bear the date of manufacture.

1. Date of manufacture shall not precede contract date by more than one year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Cable Corporation.

B. Okonite

C. Southwire Company

D. Approved Equal

2.2 FABRICATION AND MANUFACTURER:

A. NEMA WC 70; single copper conductor insulated wire; 600 volt rated insulation. Use only copper 75 °C rated cable, or 90 °C copper cable sized at 75 °C copper.

1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN, THWN-2.
2. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW XHHW-2.

B. Wire No. 10 and smaller shall be solid and wire No. 8 and larger shall be class B stranded only.

1. Exception: Fire Alarm Annunciation, control and motor wiring shall have stranded copper conductors.
2. Conductors shall have a maximum of 7 strands of wire per conductor in sizes #18 through #2, 19 strands in sizes #1 through #4/0, and 37 strands in sizes 250 kcmil through 500 kcmil

C. Conductors for use at 600 volts or below shall have 600 volt rated insulation.

1. Provide stranded conductors.

D. Interior branch circuit wiring in conduit:

1. Type THHN/THWN insulation.

E. Exterior branch circuit wiring in conduit:

1. Type THWN-2 or XHHW insulation rated for wet location.

F. Service Entrance and Feeder Circuit Wiring in conduit:

1. Type THWN-2 or XHHW insulation rated for wet location.

G. Motor circuit wiring in conduit:

1. Type THWN-2 or XHHW insulation rated for wet location.

H. Motor circuit wiring from VFD in conduit:

1. For all motors which are connected to a VFD, provide shielded power cabling designed for a VFD application for the cabling from the output of the VFD all the way to the final motor connects and any segment intermittent for a continuous electrical path. Ground per manufacturer's recommendation and as indicated in the Construction Documents. The cable shall have:

   a. Outer jacket that is chemical and sunlight resistant meeting UL 1309.
   b. Overall cable shield that is tinned copper braid plus aluminum polyester tape.
   c. XHHW-2 wiring with minimum 1.6kV withstand rating and XLPE insulation.
   d. Three soft annealed flexible stranded tinned copper power conductors.
   e. Three symmetrically insulated soft annealed flexible stranded tinned copper ground conductors in direct contact with the shield.
   f. Cable rated TC-ER for 900C.
   g. UL listed.

I. "AC", "MC" and "NM" type cables are not allowed.

2.3 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.4 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.5 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted

PART 3 - EXECUTION

3.1 SEQUENCING-SCHEDULING

A. Do not pull wire in until building is enclosed and weather tight.

3.2 INSTALLATION

A. Color code power wiring as follows:

1. 208Y/120 volt, 3-phase, 4 wire: phase A-black, phase B-red, phase C-blue, neutral-white ground conductor-green.
2. 480Y/277 volt, 3-phase, 4 wire: phase A-brown, phase B-orange, phase C-yellow, neutral-gray ground conductor-green.

B. Label on each cabling indicating type and size shall be easily visible inside the equipment and the termination location. Provide work to ensure that information is indicated.

C. Pull wire and cables into conduits and raceways in such manner that insulation will not be damaged or undue strain placed on conductors.

1. Lubricants shall be UL listed

D. Branch circuit wires in panels shall be neatly arranged with surplus wire cut off and wires tied with non-metallic ties.

1. Metallic ties not permitted

E. Conductors shall be attached to terminal screw or lug per UL listing.

F. Joints, taps and splices sizes No. 10 and smaller:

1. Ideal-Nut Connectors or Scotchlok Spring connectors

G. Joints, taps and splices sizes No. 8 and larger:

1. Aluminum/copper compression connectors

a. Install with hydraulic compression tool.

H. Joints, taps and splices sizes larger than No. 1:

1. Tape with electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half lapped layers of plastic electrical tape.

I. Plastic snap-on splice insulators are not allowed.

J. All cables and wires shall be neatly bundled and supported from structure. Do not support from ceiling grid system or other piping systems.

K. Support conductors in vertical raceways using OZ type "S" cable supports for 600-volt conductors.

L. Cable wiring methods shall not be used as a means of support for cables, raceway, or any non-electrical equipment.

M. Protect cable that passes through openings in metal enclosures. Use listed bushings or listed grommets covering all metal edges and securely fastened prior to installation of cable.

3.3 APPLICATION

A. Wire and cable boxes and reels shall bear date of manufacture.

1. Date of manufacture shall not precede contract date by more than one year.

B. Minimum conductor sizes shall be as indicated on the drawings and as follows:

1. No. 12 – Interior branch circuits of any kind
2. No. 10 – Exterior branch circuit of any kind
3. No. 14 - Signal systems, fire alarm system
4. No. 14 - Controls system (unless mnfr recommends smaller size)

C. Limit conduit fill to maximum of 6 current carrying conductors.

D. Each branch circuit for a motor load or dedicated for equipment shall be routed in individual conduit.

3.4 BRANCH WIRING

A. 208Y/120-volt circuits over 50 ft in length (from source to load): Increase wire size (phase, neutral, and ground) one size for each 100 ft of length. Increase conduit size as required.

B. 480Y/277-volt circuits over 150 ft in length (from source to load): Increase wire size (phase, neutral, and ground) one size for each 150 ft of length. Increase conduit size as required.

C. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drop on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).

D. All feeders and 3-phase circuits shall be tested after installation (prior connection and energization) for insulation and resistance. Refer to Section 260801.

1. Minimum readings shall be one million (1,000,000) or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding conductor.
2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take an insulation tester reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel until the low readings are found. The Contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.

3.5 CONNECTORS, SPLICES, AND TERMINALS

A. Connectors:

1. Except where equipment is furnished with bolted or screw type lug, use long barrel two-hole compression set pressure connectors with insulating covers. Use compression tolls and die compatible with the connectors being installed.
2. Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG conductors and smaller.
4. 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. Splices:

1. Do not splice feeders or signal cables unless authorized by the Designer.
2. Splice wires and cable only in accessible locations such as within junction boxes.
3. Make splices to carry full capacity of conductors with no perceptible temperature rise.
4. Make below-grade splices in handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
5. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
6. Plastic snap-on splice insulators are not allowed.

7. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.6 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported. Contractor shall insure bundling conductors shall not cause excessive heating of the conductors.

3.7 ACCEPTANCE TESTING

A. The party that installed the cabling shall be responsible for all testing of that cabling.

B. Acceptance testing shall be performed in accordance with Section 260801.

C. Perform electrical acceptance testing on service entrance cabling and feeders.

D. Cables, which are found defective, shall be replaced by Contractor at no expense to Owner.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL 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 DESCRIPTION OF WORK

A. Provide a complete grounding system for services and equipment as required by State Codes, NEC, applicable portions of other NFPA codes, and as indicated herein.

B. Refer to the drawings for grounding diagram.

C. Maximum resistance to ground shall be less than 10 ohms.

1.3 REFERENCE STANDARDS

A. UL 467 Electrical Grounding and Bonding Equipment

B. ANSI J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

C. ASTM B 3 – Specification for Soft or Annealed Copper Wire.

D. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

E. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

F. IEEE C2 – National Electrical Safety Code (ANSI).

G. NETA MTS – Maintenance Testing Specifications.

H. NFPA 70 – National Electrical Code.

I. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

1.4 DEFINITIONS

A. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.

1.5 SUBMITTALS

A. Submit shop drawings for all components provided under this section.

B. Test Reports:

1. Test reports of resistance to earth.

2. Testing shall be done based on "Fall-of-Potential" method or alternate equal based on the site restrictions.
3. Each test report shall include:
   a. Date of test, soil moisture content, and soil temperature
   b. Test operator
   c. Instrument or other test equipment used
   d. Electrode designation or location
   e. Ground impedance in ohms
   f. Assumptions made - if required

1.6 CLOSEOUT SUBMITTALS:

A. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Dimensioned plans showing grounding electrode locations and connections to building steel and building systems.

B. Operation and Maintenance Data: For grounding to include the following (as applicable) in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at test wells and ground rings based on NETA MTS.
   2. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
   3. Include recommended testing intervals

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ground rods shall be 3/4" x 10'-0" copperweld.

B. Ground connectors shall be exothermic welded type as manufactured by Erico/Cadweld, Furseweld (Thomas & Betts), or ThermOweld.

C. Connections at ground test wells shall be mechanical type.

D. Grounds in concealed, outdoor or in damp/wet locations shall meet IEEE 837 requirements and shall be UL 467 or third party listed.

E. Grounded conductors (system neutral) shall be copper with white (208/120V) or gray (480/277V) insulation.

F. Branch circuit and feeder grounding conductors shall be copper, with green insulation. Bare conductors are acceptable for bonding connections to ground bars, building steel, and ground ring.

G. MGB Grounding Bus: Horizontal rectangular bars of annealed copper, as indicated on drawings.

H. All building grounding systems and lightning protection system shall be connected to the building ground loop. Refer to the drawings for additional grounding information.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction 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. Compression Connectors: Irreversible type

PART 3 - EXECUTION

3.1 SEQUENCING, SCHEDULING

A. Service grounds shall be permanently attached before permanent building service is energized.

B. Equipment grounds shall be permanently attached prior to energizing equipment.

C. Testing and associated report shall be provided prior to energizing equipment.

3.2 INSTALLATION

A. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.

B. 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.

C. Common Ground Bonding 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.

D. Ground Rods: Install ground rods 30” minimum below finished grade.

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. For grounding electrode system, install number of rods indicated on drawings and 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.

E. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12” deep, with cover.

1. Test Wells: 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.

F. 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 so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

G. Grounding for Steel Building Structure: Install as indicated on drawings.

H. Make grounding connections on surfaces, which have been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

I. Make grounding connections tight with 3rd party listed grounding devices, fittings, bushings, etc.

J. Ground Ring: Install a grounding conductor, electrically connected to each ground rod and to each indicated item, extending around the perimeter of area indicated on drawings.

1. Install tinned-copper conductor #4/0AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24” from building/enclosure and 30” below grade.

K. Every circuit shall have a ground wire. The raceway system shall not be used soley for grounding continuity.

L. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.

M. Provide separate green wire grounding conductor for each branch circuit to motor or fixed equipment connection.

N. Bond to components of raceway system, such as junction boxes, starter or disconnect switch enclosures, equipment cases, etc.

O. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.

P. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

Q. Grounding conductors for branch circuits shall be size indicated in NEC, except minimum size grounding conductor shall be No. 12 AWG.

R. Each branch panel feeder originating at switchboards shall have an identified grounding conductor originating at ground bus in switchboard and terminating at ground bus in panelboard. Size as indicated in NEC except in no instance smaller than No. 8 AWG.

S. Provide grounding conductor in addition to neutral conductor and in no case shall neutral conductor serve as grounding means. Provide separate neutral conductors for each circuit unless noted otherwise on the drawings.

T. Provide a full-sized bonding jumper across pipe connections to water meters, dielectric couplings in a metallic cold-water system, and across expansion/deflection couplings in conduit and piping system.

3.3 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

3.4 TESTING

A. Perform Fall of Potential Test per IEEE guidelines and 3-point (or 4-point) testing equipment manufacturer recommendations.

B. Overall distance of 3-point test shall be a minimum of 10 times the length of the ground rod.

C. The measurements taken during this test shall be plotted on a graph to indicate resistance to ground versus distance from connection to grounding system to measurement probe.

D. If a plot of the test values (10 measurements, minimum per test) does not indicate a definite plateau, the test shall be repeated in different locations until the test value plot does indicate a definite plateau.

E. Interpret test results in writing and submit to Designer.

3.5 ALTERNATE TEST METHOD

A. If it is determined that the fall-of-potential test is not practical due to the site restrictions and urban environment, Contractor shall provide alternate test method for review and approval by Owner and Designer.

B. Contractor shall submit detailed testing plan to include procedures, equipment, etc. as well as documentation from nationally recognized testing agency that proposed plan is legitimate and adequate to confirm grounding system performance. The “ground clamp method” is also acceptable.

3.6 INSPECTION

A. Prior to backfilling, completed system shall be inspected by commissioning authority.

END OF SECTION 260526

SECTION 260527 - LIGHTNING PROTECTION SYSTEM

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 DESCRIPTION

A. This Section includes lightning protection systems consisting of air terminals, roof conductors, bonding conductors, down conductors, fastener connections, and grounding.

B. Refer to Section 260526 for additional grounding requirements.

C. Refer to Section 264300 for Surge Protection requirements.

D. Refer to Section 275319 for Emergency Responder Radio sytem antenna on roof which shall be tied into the system.

E. Provide compliance with NFPA 780 Section 4.20 and UL 96A

1.3 REFERENCE STANDARDS

A. ANSI/NEMA GR1 - Grounding Rod Electrodes and Ground Rod Electrode Couplings

B. NFPA 70 - National Electrical Code

C. NFPA 780 - Standard for the Installation of Lightning Protection Systems

D. UL 96 - Lightning Protection Components

E. UL 96A - Installation Requirements for Lightning Protection Systems

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer's descriptive and technical literature and catalog cuts.

B. Shop Drawings:

1. Submit installation shop drawings for overall lightning protection system. Include physical layout of equipment, mounting details, and relationship to other parts of the work.
2. Submit detail drawings for each major component.
3. Location, size, and material of grounding electrodes, and connection type.
4. Roof adhesive data for air terminals mounted on single-ply roofing.

C. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both terminal assembly and single-ply roofing material.

D. Coordination with Surge Protection submittals and installation to satisfy UL 96A criteria.

E. Copy of Owner's UL Lightning Protection Inspection Certificate.

F. Test Reports:

1. Note that only one test report for the grounding system as specified below as well as in Section 260526 is required
2. Submit test report date of test, soil moisture content, soil temperature, test operator, instrument or other test equipment used, electrode designation or location matching that on shop drawings and ground impedance in ohms.

G. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

H. Closeout Submittals:

1. Project record documents:

a. Record active location of all lighting protection system components.

2. Operation and maintenance data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventative maintenance instructions.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Lightning protection system materials shall consist of standard products of a manufacturer regularly engaged in production of lightning protection systems and shall be manufacturer's latest UL approved design.
2. Installer of lightning protection system shall be UL listed.

B. Regulatory Requirements:

1. Lightning protection system shall comply with NFPA 780, UL 96, and UL 96A.

C. Certifications:

1. Furnish Owner with UL Lightning Protection Inspection Certificate upon completion of installation providing proof that lightning protection system is in compliance with UL 96 and UL 96A standards.

1.6 SEQUENCING

A. Coordinate installation of lightning protection with installation of other building systems and components, including supporting structures and building materials, metal bodies requiring bonding to lightning protection components, exterior and interior building finishes, and building roofing.

B. Grounding system testing and associated report shall be performed/provided prior to the building being energized.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Erico International Corporation

B. Thompson Lightning Protection Company

C. Harger Lightning Protection, Inc.

D. Heary Brothers Lightning Protection Company, Inc.

E. National Lightning Protection Corporation

F. Approved equal

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. NFPA 780, UL 96

B. Materials: air terminals, main and cross-run roof conductors, bonding and down conductors, conductor fasteners, and connections: Class II:

1. Air terminals: solid type with safety tip, 10" in height minimum, above object to be protected when spaced at intervals not exceeding 20 ft, with mounting base.

C. ANSI/NEMA GR1 Grounding Electrodes: 3/4" x 10 ft long copper-clad steel ground rod.

D. Ground Ring Electrode, as shown on drawings and as follows:

1. Stranded copper unless noted otherwise.
2. Stranded aluminum on the roof.
3. Stranded tinned copper for ground ring.

E. Ground Connectors:

1. Bronze of clamp type and bronze clamp accessories.
2. Exothermic weld (Cadweld or equal).
3. Provide in accordance with requirements in Section 260526.
4. Air terminals, conductors, fasteners, and connectors shall be galvanically compatible with surfaces they are mounted to.
5. Provide copper materials in all locations except where use of aluminum materials is necessary for galvanic compatibility.
6. Aluminum materials on copper roofs are not acceptable.
7. Provide aluminum materials where mounted on aluminum roofing, siding, or other aluminum surfaces.
8. Provide bimetallic fittings when joining metals that are not galvanically compatible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lighting protection to comply with UL 96A, NFPA 70, and NFPA 780. Conform to the most stringent requirement in NFPA 780.

B. Bond exterior metals including flashing, roof drains, vent stacks, fans, water pipes, metal raceways, enclosures, frames, and other non-current carrying metal parts of electrical and mechanical equipment on roof to lightning protection system.

C. Bond lower end of exhaust ducts, vent stacks, etc., passing through roof.

D. Run bonding jumpers continuously horizontally or down from point of bond to point of connection to main conductor.

E. Make down conductors electrically continuous, with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Protect down conductors, when routed inside the building or outside of cooling tower cells, to prevent physical damage or displacement to the conductor with PVC Schedule 40 conduits. Exterior conduits shall be painted to match adjacent surface. Provide conduits in accordance with requirements in Section 260533.

F. Conceal system conductors and interior conductors.

G. Notify Designer at least 72 hrs before concealing lightning protection system components.

H. Below-grade or concealed cable connections: use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

I. Exposed cable connections: exothermic welded connection except approved mechanical connections at test points (i.e. test wells).

J. Air terminals mounted on single-ply roofing: use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. For roofing work, refer to Division 07.

K. Attach each down conductor to grounding electrode by exothermic welding.

L. Provide grounding electrodes with top two feet below finished grade.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the present of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Apply for inspection by Underwriters Laboratories, Inc. (UL) to obtain UL Lightning Protection Inspection Certificate.

B. Verify that lightning protection surge protection devices are installed on all incoming power and communications lines, in order to obtain UL Lightning Protection Inspection Certificate.

C. Test grounding system to ensure continuity prior to backfilling and paving: check that resistance to earth does not exceed 10 ohms, measured by "Fall-of-Potential" method.

D. Make resistance measurements in dry weather not earlier than 48 hours after rainfall.

E. Make visual inspection to verify that there are no loose connections that may result in high resistance joints, and conductors and system components are securely fastened to their mounting surfaces and are protected against accidental mechanical displacement.

END OF SECTION 260527

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL 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 DESCRIPTION

A. Provide supporting devices as specified and as required for proper support of conduit and electrical equipment.

B. Provide supporting steel, not indicated on structural drawings, that is required for installation of electrical equipment and raceway, including angles, channels, beams, etc. to suspend on floor support equipment.

C. Support for conditions of operation to prevent excess stress and allow for proper expansion and contraction.

D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. Straps shall have steel or malleable backing plates when conduit is installed on interior or exterior surface of exterior building wall.

1.3 SUBMITTALS

A. Submit shop drawings for equipment provided under this section.

1. Equipment this section, including:

a. Manufacturer's name
b. Model numbers
c. Materials of construction and load ratings (lbs

1.4 DESIGN CRITERIA

A. Support materials shall be galvanized steel (interior) and hot dipped galvanized steel or stainless steel (exterior) unless specifically indicated.

B. Design, structural support members and support devices with safety factor of not less than 2.0.

C. Hangers, support devices and hardware shall be steel and shall have factory standard galvanized finish for indoor application, and hot-dipped galvanized finish for outdoor application. Coat cut edges, welds or damaged finish with galvanized paint.

D. Where conduit can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

E. Unless otherwise indicated, continuous insert channels are not allowed.

F. Punching, drilling, or welding of building structural steel is not allowed unless approved by Designer.

G. Application of concrete inserts and concrete anchors shall be reviewed and approved by Designer prior to installation.

H. Proposed weld attachments to building structure shall be reviewed by Designer.

1. Execution of this work may be assigned to General Trades responsible for building structural steel.
2. Cost for this work, however, will remain the responsibility of this Contractor.

I. Fasteners including concrete anchors for seismic application shall meet ICBO Evaluation Report and requirements of local authorities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Conduit Hangers and Supports

1. Erico
2. Cooper B-Line
3. Fastenal

B. Beam Clamps

1. Erico
2. Cooper B-line
3. Fastenal

C. Wall Anchors

1. Hilti
2. Rawl
3. Fastenal

D. Metal Framing Support System (Strut System)

1. Cooper B-Line
2. Kindorf
3. Unistrut

2.2 HANGER RODS

A. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electro-plated zinc or hot dip galvanized finish.

C. Size rods for individual hangers and trapeze supports as required.

2.3 BEAM CLAMPS

A. Bolt-On

B. Hammer-On

C. Malleable Iron

D. Stamped Steel

E. Support 1/4" and 3/8" threaded rod.

2.4 WALL ANCHORS

A. Flush or shell type, meeting description in Federal Specification FF-S-325, Group VIII, Type 1 for expansion shield anchors.

B. Select anchors with minimum safety factor of 8.0.

2.5 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Channels shall have epoxy paint or electro-galvanized finish.

B. Channels shall not be lighter than 12 ga.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install all supports as required to fasten electrical components required for project, including free standing supports required for those items remotely mounted from building structure, catwalks, walkways, etc.

B. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only).

C. Select and size building attachments in accordance with manufacturer's instructions.

D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors in concrete structures; sheet metal screws in sheet metal studs and wood screws in wood construction.

E. Fabricate supports from galvanized structural steel or steel channel. Use hexagon head bolts with spring lock washers under nuts.

F. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.

G. Coordinate hanger and support installation to avoid work of other trades.

H. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

I. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.

J. Do not drill structural steel members unless previously approved by Designer.

K. Do not support equipment or conduit from metal roof decking.

L. Conduit shall not be supported by other conduit.

M. Install surface-mounted cabinets and panelboards with minimum of 4 anchors. Provide steel channel supports to stand cabinet 1" off wall.

N. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud wall.

O. Refer to Section 260000 for requirements of personnel injury protection guards for supporting devices.

3.2 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 1/2" or smaller.

3.3 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

3.4 CONDUIT MOUNTING PEDESTALS

A. Use for conduit on roof. Install bottom of pedestal flat on roof deck, insulate exterior of pedestal, flash and counter flash.

3.5 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be reviewed and approved by Designer prior to installation.

END OF SECTION 260529

SECTION 260530 – FLOOR AND WALL BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. This is a supplemental section to 260533 which includes floor boxes and fire-rated poke-thrus.

B. Section Includes:

1. Concrete Floor Boxes
2. Wall Boxes
3. Specialty Boxes

C. Related Sections:

1. Section 260533 - Raceway and Boxes for Electrical Systems.
2. Section 262726 - Wiring Devices.

1.2 REFERENCES

A. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

B. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

1.3 SYSTEM DESCRIPTION

A. Boxes located as indicated on Drawings, and at other locations required for wire pulling, equipment connections, and compliance with regulatory requirements. Boxes are shown in approximate locations unless dimensioned.

1.4 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation instructions.

C. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 COORDINATION

A. Coordinate Work with other operations and installation of finish materials to avoid damage to adjacent materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: FSR Inc., Hubbell, Chief/Legrand, RPVisuals

B. Requests for substitutions will be considered in accordance with provisions of Division 01.

2.2 CONCRETE FLOOR BOXES

A. Concrete Floor Boxes General: Comply with NEMA OS 1 and are both UL and CUL listed. For power, audio, video, telecommunications and data.

B. Floor box for concrete floors covered with carpet, tile and wood. Provided with stainless steel quarter turn compression latches and neoprene gaskets and is UL scrub water resistance approved for carpet, tile and wood floors.

1. Provided with one angled bracket to handle 2 single, 1 triple gang opening.
2. Provided with 1/2 inch (12 mm), 3/4 inch (19 mm), 1 inch (25 mm) or 1-1/4 inch (32 mm) knockouts.
3. Temporary Construction Cover: 11 gauge (3 mm) steel.
4. Cover: Lift off type, 11 gauge (3 mm) finished steel with:

   a. 1/4 inch (6 mm) Brass Carpet Flange, Lift off door, Gray or black, Brass or Aluminum carpet edging .25 inch (6 mm) high.
   b. 1/4 inch (6 mm) Square Brass Flange, Lift off door, Mitered brass carpet edging .25 inch (6 mm) high.
   c. 1/4 inch (6 mm) Aluminum Carpet Flange, Lift off door.
   d. 1/4 inch (6 mm) Square Aluminum Flange, Lift off door.
   e. No Flange with Hinged Door in Black Sandtex.
   f. No Flange with Hinged Door in Light Oak Sandtex.

5. Box Size 8.00 inches by 14.00 inches (203 mm by 356 mm).
6. Box Height: 5.125 inches (130 mm).

C. Pour Pan Accessory: For use under floor boxes for concrete floors on grade and that may rest on soil, rock or gravel. Unit comes with extended length leveling feet, and the unique "pan wings" prevent the pan from shifting during the pour.

1. Galvanized steel with four 5 inch (127 mm) adjustment legs.

   a. Overall Size: 26 inches by 19-3/4 inches (660 mm by 502 mm).
   b. Bottom Size: 15-3/4 inches (400 mm).
   c. Depth: as required by slab.

D. Fire Rated Poke-Thru concrete floor boxes and covers, sub-plates and accessories.

1. 8 inch Fire Rated Poke Through:

a. Features:

1) Drop down cable access doors to reduce trip hazards.
2) Sub-plates accept IPS Plates and third party devices.
3) NEMA WD6 Device spacing.

b. Specifications:

1) 2 hour fire rating.
2) 180 degree access door opening.
3) Flange height 0.15 inch (4 mm) and complies with ADA requirements.
4) Power wiring junction box included.
5) Complies with UL514A for scrub water test.
6) 1000 lb. cover load rating with 2 x safety factor.
7) ULC and cULus rated.
8) EMT fitting adapter with (1) 1 inch and (1) 1.5 inch stub, Junction Box

c. Covers:

1) Coordinate color with Architect.

2.3 WALL BOXES

A. Large Project wall box, 14 gauge steel construction. Designed to fit 2 inch by 4 inch (51 mm by 102 mm) studs and provides 4 pre-wired AC outlets along one vertical side of the box that are isolated from the 4 accessory plate mounting brackets to allow AC and low-voltage connections within the same box. Box has a 1/2 - 3/4 inch concentric KO on top and bottom of the box for AC conduit connections. 1 inch KO's in the divider plates allow the use of one or more accessory plates for AC connections.

1. Three accessory plate brackets are punched for a single gang Decora opening.
2. Box is 14.20 inches (361 mm) wide by 17 inches high (432 mm) by 3.74 inches (100 mm) deep.
3. Cover Finish: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify locations of floor boxes and outlets in prior to rough-in.

C. Verify openings in access floor are in proper locations.

D. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned.

C. Orient boxes to accommodate wiring devices oriented as specified in 26 27 26 - Wiring Devices.

D. Set floor boxes level.

E. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.

F. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches (150 mm) separation. Install with minimum 24 inches (600 mm) separation in acoustic rated walls.

G. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

H. Install stamped steel bridges to fasten flush mounting outlet box between studs.

I. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

J. Support boxes independently of conduit.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 CLEANING

A. Division 01

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION 260530

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL 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 DESCRIPTION

A. This Section includes raceways, fittings, wireways, pull and junction boxes, and raceway seals.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. ANSI C80-1 - Rigid Steel Conduit-Zinc Coated (GRS)

C. ANSI C80-3 - Electrical Metallic Tubing-Zinc Coated (EMT)

D. ANSI C80-5 - Aluminum Rigid Conduit-Zinc Coated (ARC)

E. ASTM A 53/A 53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

H. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

I. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit

K. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

L. NFPA 70 - National Electrical Code

M. UL 1 - Flexible Metal Conduit

N. UL 6 - Electrical Rigid Metallic Conduit-Steel

O. UL 6A - Electrical Rigid Metallic Conduit-Aluminum and Stainless Steel

P. UL 360 - Liquid-Tight Flexible Steel Conduit

Q. UL 514A - Metallic Outlet Boxes

R. UL 514B - Conduit, Tubing, and Cable Fittings

S. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings

T. UL 797 - Electrical Metallic Tubing-Steel

U. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings

V. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit

1.4 SUBMITTALS

A. Product Data:

1. Raceways
2. Fittings
3. Bushings
4. Raceway seals
5. Floor Boxes
6. Poke-thrus

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

C. Closeout Submittals:

1. Project Record Documents:

a. Approved submittal with Designer’s comments.
b. Record actual routing of raceways larger than 2".
c. Record actual location and mounting heights of wireways, wall ducts, and, pull and junction boxes.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Protect PVC conduit from sunlight.

C. Comply with manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard one-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel.

B. Rigid Aluminum Conduit (RAC): ANSI C80.5; heavy wall aluminum. Aluminum fittings, conduit bodies, and boxes shall be restricted to areas where aluminum raceways are permitted only. Aluminum shall not be used with rigid galvanized steel raceway systems.

C. Fittings (couplings, conduit bodies, connectors and bushings): NEMA FB 1, UL 514B; steel alloy; threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings for conduits 2" and smaller; conduit bodies cover: stamped steel (interior), cast steel or aluminum (exterior), with stainless steel screws and neoprene gaskets; PVC coated to match conduit.

D. Fittings Manufacturers: Cooper Crouse-Hinds, Carlon Electric Products, O-Z/Gedney, Appleton, Hubbell, Thomas & Betts.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. ANSI C80.3, UL 797; galvanized steel tubing

B. Fittings (couplings, conduit bodies, and connectors): NEMA FB I, UL 514B; steel, concrete tight gland compression type connectors with double locknuts and insulated throat; conduit bodies cover: stamped steel, with stainless steel screws and neoprene gaskets. Indentor, drive-on, die-cast or pressure cast fittings not permitted.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1; interlocked steel.

B. Fittings: NEMA FB I, UL 514B; steel.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. UL 360; interlocked steel, with PVC jacket.

B. Fittings: NEMA FB 1, UL 514B; steel.

2.5 RIGID NONMETALLIC CONDUIT (RNC)

A. NEMA TC 2, UL 651; Schedule 40 (encased in concrete) or 80 PVC (direct buried).

B. Fittings: NEMA TC 3, UL 651.

2.6 FLOOR BOXES

A. Metal Floor Boxes:

1. UL514A listed.

B. Combination Flush Floor Boxes:

1. Above Grade or On Grade: cast iron or stamped steel with epoxy coating, watertight design approved for use in on-grade and above-grade concrete floor applications, with 4 independent wiring compartments and capacity for up to 5 duplex receptacles or communication devices. Box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and 2 receptacle brackets. Conduit knockouts total four 1" and four 1-1/4". Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.
2. Covers: Activation Covers - die-cast aluminum with textured aluminum finish, and black or brass power-coated paint finishes as selected by Architect. Cover: flanged or flangeless, as required, with options for tile or carpet inserts, blank covers, or covers with one or two 1" liquid tight conduit openings for furniture feed applications.
3. Communication Modules Mounting Accessories: per requirements in Division 27.
4. FSR FL-700 for the on-grade first floor or equal by Legrand or Hubbell.

C. All above grade floor boxes shall be fire rated. Refer to 2.6.F.

D. In slab above grade: rated poke-thru devices (power only) or fire-rated combination floor boxes as shown on the A/V and IT drawings.

E. Poke-Through Fittings: assembly comprising service fitting, scrub water cover, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

1. Fire Rating: 2 hours.
2. Service Fitting Type: flush
3. Finish: satin aluminum, confirm with architect
4. Configuration: four single receptacles and four openings reserved for telecommunication jacks. Refer to electrical and IT drawings for final number of receptacles and jacks in the Poke-Through.

F. Fire-rated floor boxes (above grade): assembly comprising gang mounting bracket, scrub water cover, concrete deck pan, leveling bolts, adjustable fittings in 1-1/2" knock-outs, and floor box for conduit termination. Fire rating to match floor rating based on concrete coverage around the box within a pan. Basis of design is Legrand EFB8S-FC. Refer to A/V drawings for number of receptacles, A/V and data. All receptacles and data shown on power and data plans shall be mounted in the combination A/V floor boxes. Do not provide separate boxes. Typical installation is two duplex receptacle and 4 data plus conduit and openings for A/V.

G. Coordinate finish of the cover with the architect during the shop drawing review process. Contractor to submit to the architect the shop drawing for review and approval by the Architect and the Engineer.

H. Table - Floor boxes or poke-thru device types:

Floor box type	Utilities in box	Cover type	Notes
2-gang floor box	2-duplex power only	Rectangular, flush, 2 large cable egress doors, 180-degree access, finish by architect	In-grade cast box, scrub water rated, first floor
4-gang floor box	2-duplex power & 4 data	Rectangular, flush, 2 large cable egress doors, 180-degree access, finish by architect	In-grade cast box, scrub water rated, first floor
6-gang floor box	2-duplex power, 4 data, A/V provisions	Rectangular, flush, large cable egress doors, 180-degree access, finish by architect	In-grade box, FL-700, scrub water rated, first floor

Poke thru 2-hour rated, recessed connections, 4” core	2-duplex power only	Round, die cast aluminum, 180 degree opening, finish by architect	Two egress doors for cables while in use. Second and third floors
Poke thru 2-hour rated, recessed connections, 6” core	2-duplex power, 4 data	Round, die cast aluminum, 180 degree opening, finish by architect	Two egress doors for cables while in use. Second and third floors
Poke thru 2-hour rated, recessed connections, 8” core	2-duplex power, 4 data, A/V provisions	Round, die cast aluminum, 180 degree opening, finish by architect	Two egress doors for cables while in use. Second and third floors

I. Any floor boxes shown above the first floor shall be fire rated per 2.6.F.

J. Manufacturers: FSR, Wiremold, Hubbell, Legrand

2.7 AV BOXES

A. Refer to AV drawings for specific AV wall, ceiling, and floor box requirements.

B. Provide all rough-in for AV. Refer to drawing EA1.00.

C. AV cable shall be installed in its own raceway. Do not run in cable tray for IT.

2.8 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts. Use in interior locations.

1. Luminaire and Equipment Supporting Boxes: rated for weight of equipment supported, 1/2" male fixture studs, where required.

B. Cast-Metal Outlet Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover and threaded hubs. Use in exterior locations.

C. Gangable type boxes are not allowed.

D. Manufacturers: O-Z/Gedney, Raco, Cooper Crouse-Hinds, approved equal

2.9 PULL AND JUNCTION BOXES

A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1, cast steel with ground flange, gasketed cover and stainless-steel cover screws.

C. Minimum size: 4" square by 2-1/8" deep for use with 1" conduit and smaller; 4-11/16" square by 2-1/8" deep for use with 1-1/4" conduit and larger.

D. Sheet Metal Boxes larger than 12" in any direction: hinged cover or chain installed between box and cover.

E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.

2.10 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing 4" (+/-2") raceway movement.

B. Manufacturers: OZ/Gedney AX Series, or equivalent by manufacturer listed in 2.1.C.

2.11 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals

B. Manufacturers: New construction - OZ/Gedney FSK Series, existing construction - OZ/Gedney CSM Series, or equivalent by manufacturer listed in 2.1.D.

2.12 RACEWAY SEALING FITTINGS

A. For 1 through 4 conductors: Manufacturer listed in 2.1.D.

B. For greater than 4 conductors: Manufacturer listed in 2.1.D.

C. Low-temperature locations: Manufacturer listed in 2.1.D.

2.13 CABLE SUPPORTS

A. Manufacturers: Manufacturer listed in 2.1.D.

2.14 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052" or 0.138" thickness and of length to suit application.

2.15 SUPPORT

A. All exterior fasteners shall be hot dipped galvanized or stainless steel.

B. Conduit supports for horizontal or vertical single runs: Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or channel system with appropriate components. Spring type pressure clamps may be used with conduit through 3/4".

C. Conduit supports for horizontal and vertical multiple runs: Channel systems with appropriate components. Horizontal runs to be supported with appropriate sized rods and vertical runs anchored to structure. Spring type pressure clamps may be used with conduit through 3/4".

D. Vertical conduit runs 1-1/4" and larger passing through floors shall be supported at each floor with conduit riser grips.

E. Riser sleeves shall be supported by unistrut installed on nearest wall with unistrut straps to secure sleeve or by other approved method.

F. Conduit installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of ¼" using "clamp-backs" or strut.

G. Pipe straps of clamps shall be secured by means of:

1. Toggle bolts on hollow masonry
2. Metal expansion shields and machine screws, or standard pre-set inserts, on concrete or solid masonry.
3. Machine screws or bolts on metal surfaces.
4. Wood screws on wood construction.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate size and location of required built-in openings.

B. Coordinate with Designer for cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.

C. Verify with Designer surface raceway installations except in mechanical, electrical, and communications rooms.

D. Coordinate routing of through-roof conduits.

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 260593.

F. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.

G. Verify with manufacturer that "touch-up" paint kit and PVC-coating kit are available for use.

3.2 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway's installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Raceways:

1. Comply with ANSI/NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
2. Arrange raceways to maintain headroom and present neat appearance.
3. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation. Contractor shall determine exact routing/location in the field.
4. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
5. Do not install raceways in structural or topping floor slabs, except where noted on plans.
6. Cut raceways square using saw or pipe cutter.
7. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 2", unless sweep elbows are required. Bend raceways according to manufacturer's recommendations. Do not use torches or open flame to aid in bend of PVC conduit.

8. Use raceway fittings compatible with raceways and suitable for use and environment.
9. Provide bushings on raceways.
10. Raceways minimum sizes:
    a. Minimum raceway size: 3/4", except as noted on drawings.
    b. Minimum home run size: 3/4", except as noted on drawings.
    c. Minimum exterior raceway size: 1.25” except as noted on the drawings.
    d. Minimum size for liquid tight flexible metal conduit is 3/4".
    e. Minimum raceway size for communications: 1”, except as noted on drawings.
11. Install empty raceways 2-1/2" and larger with No. 10 galvanized fish wire; install nylon pull cord in raceways smaller than 2-1/2"; leave at least 12" of slack at each end of pull wire.
12. Feed devices in exterior or load-bearing walls by horizontal conduit runs. Install horizontal conduit runs from device to device on same wall. Do not install horizontal bends in conduit around corners. Feed devices on same wall vertically from above or junction box in suspended ceiling.
13. Raceways Supports:
    a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
    b. Raceway supports for horizontal or vertical single runs:
        1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
        2) Spring steel type pressure clamps for raceways 3/4" and smaller.
    c. Raceway supports for horizontal and vertical multiple runs:
        1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
        2) Support horizontal runs with appropriately sized rods.
        3) Anchor vertical runs to structure.
        4) Spring-steel type pressure clamps for raceways 3/4" and smaller.
    d. Vertical raceway runs 1-1/4" and larger passing through floors shall be supported at each floor with pipe riser clamps.
    e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
    f. Secure raceways in metal stud walls, to prevent rattling.
    g. Arrange raceway supports to prevent misalignment during wiring installation.
    h. Do not fasten raceways to corrugated metal roof deck.
    i. For fasteners and supports, including but not limited to, steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 260529.
14. Identify raceways per requirements in Section 260553.
15. Ground raceways per requirements in Section 260526.
16. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes (e.g. panelboards, starters, VFDs, controllers, etc.) outdoors, and in unfinished locations to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

B. Boxes:
1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
2. Install appropriate cover on surface-mounted boxes:
    a. Raised device covers on 4" square and 4-11/16" boxes and handy box covers on handy boxes, etc.
    b. Device covers that are square drawn or square cut on boxes in block.

c. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
d. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

3. Set outlet boxes parallel to construction and independently attached to same.
4. Do not install back-to-back and through-the-wall boxes. Install with minimum 6" horizontal separation between closest edges of boxes. Install with minimum 24" separation in acoustic-rated walls.
5. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
6. Box Support:

a. Mount boxes straight.
b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
d. Do not support boxes with tie-wire.
e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
f. Support boxes independently of raceways.
g. Install adjustable steel channel fasteners for hung ceiling outlet box.
h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
i. Do not install boxes to ceiling support wires or other piping systems.

7. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.
8. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
9. Install boxes to be permanently accessible.
10. Do not intermix conductors from one system in same junction box or pull box unless shown or specifically authorized otherwise.
11. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
12. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.
13. Drawings do not necessarily show every pull or junction box required. Add required boxes, as necessary.

C. Raceway Penetration Seals:

1. Exterior wall surfaces above grade: Install watertight seal around raceways. For concrete construction above ground level, cast raceway in wall or core drill wall and hard pack with mixture of equal parts of sand and cement. For other types of construction, use method acceptable to Designer.
2. Exterior surfaces below grade: Provide watertight seal around raceways. Cast raceway into wall (or floor) or use manufactured seal assembly.
3. Roofs: Install flashed and hot mopped weatherproof seal, or pitch pan filled and sealed to be weatherproof where raceway penetrates roof membrane. Install weatherhead on raceway stubups penetrating roof.
4. Different temperatures: seal conduit where exposed to differing temperatures such as a cold room.

D. Raceway Ceiling Fittings:

1. Install listed watertight seals to prevent passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of building, where raceway passes between areas of different temperatures where raceway enters room which at any time is low or high temperature room and where raceway enters room which at any time is subject to internal air pressures above or below normal.

2. Install watertight seals in interior of raceways passing through building roof, ground floor slab (when raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.

E. Sleeve Installation for Electrical Penetrations:

1. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 260593.
2. Concrete Slabs and Walls: install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
4. Rectangular Sleeve Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50" and no side greater than 16", thickness shall be 0.052".
   b. For sleeve cross-section rectangle perimeter equal to, or greater than, 50" and 1 or more sides equal to, or greater than, 16", thickness shall be 0.138".
5. Fire-Rated Assemblies: install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
6. Cut sleeves to length for mounting flush with both surfaces of walls.
7. Extend sleeves installed in floors 2" above finished floor level.
8. Size pipe sleeves to provide 1/4" annular clear space between sleeve and raceway unless sleeve seal is to be installed.
9. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
10. Interior Penetrations of Non-Fire-Rated Walls and Floors: seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Maintenance of Joint Protection" for materials and installation.
11. Fire-Rated-Assembly Penetrations: maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 260593.
12. Roof-Penetration Sleeves: seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
13. Aboveground, Exterior-Wall Penetrations: seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annual clear space between pipe and sleeve for installing mechanical sleeve seals.
14. Underground, Exterior-Wall Penetrations: install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1" annual clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 APPLICATION

A. Raceway uses permitted and not permitted per NFPA 70 requirements and as described below.

B. Rigid Steel Conduit (RSC) shall be installed as follows:

1. Inside the building in all unfinished spaces unless noted otherwise.
2. Exterior installations above grade. Paint threads to avoid rusting.
3. Elbows for transition from ductbank to above grade or penetrating buildings.

C. Rigid Aluminum Conuit (RAC) Conduit shall be installed as follows:

1. Outside the building at the cooling tower locations.

D. Electrical Metallic Tubing (EMT) shall be installed as follows:

1. Inside finished spaces inside the building in the office and bathroom.

E. Flexible Metal Conduit (FMC) shall be installed as follows:

1. Use flexible metal conduit for final connections for:

a. Final connections to recessed luminaires in lengths not to exceed 6 ft.

F. Liquid Tight Flexible Metal Conduit (LFMC) shall be installed as follows:

1. Use liquid tight flexible conduit, not over 4 ft in length, for final connections to:

a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment).
b. Instruments and control devices.

G. Rigid Nonmetallic Conduit (RNC) shall be installed as follows:

1. Concrete encased ductbank (use PVC Sch 40).
2. Direct burial, in sand fill on bottom and top (use PVC Sch 80).

H. 1/2" Raceway permitted:

1. Prewired luminaires.
2. Prewired portable equipment.
3. In door frames for electronic security system.

3.5 RACEWAY WIRING METHODS

A. Underground Service cabling and feeders: install PVC Sch 40 conduit encased in concrete ductbank.

B. Underground branch circuits: install PVC Sch 80 conduit direct buried. Use metallic raceway for the Intraprofessional Clinic 1012 only.

C. Under slab on grade: install PVC Sch 40 conduit encased in concrete ductbank. Elbows to transition to above grade shall be RGS. Use metallic raceway for the Intraprofessional Clinic 1012 only.

D. Outdoor locations, above grade: install rigid steel conduit; install cast metal outlet, pull, and junction boxes.

E. Indoor Locations: install rigid steel conduit or electrical metallic tubing (per Section 3.4); install cast or metal junction and pull boxes. Install flush mounting outlet box in finished areas.

3.6 FIELD QUALITY CONTROL

A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.

B. Replace damaged component of raceway system or install new raceway system.

C. Inspect components, wiring, connections and grounding.

3.7 REPAINTING

A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.

B. Remove damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.

C. Paint exposed threads of metal conduits routed in exterior locations above grade. Paint shall be manufacturers specifically of this application.

3.8 ADJUSTING

A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.

B. Install knockout closures in unused openings in boxes.

C. Align adjacent wall-mounted outlet boxes for switches and similar devices.

3.9 CLEANING

A. Clean interior and exterior of boxes, to remove dust, debris and other material.

END OF SECTION 260533

SECTION 260533.13 - SURFACE RACEWAY SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables

B. Section 260526 - Grounding and Bonding for Electrical Systems

C. Section 260553 - Electrical Systems Identification

D. Section 262726 - Wiring Devices

E. Section 270553 - Communications Systems Identification

F. Section 271500 - Communications Horizontal Cabling

1.2 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This section includes surface metallic raceway system for branch circuits and data network.

B. Surface raceway system shall consist of raceway bases, appropriate fittings and device mounting plates necessary for complete installation.

C. Lengths of raceways shown on drawings are illustrative and diagrammatic only and are not accurate. Raceways shall be provided completely installed to match lengths of cabinets and shelving as indicated on (laboratory) casework shop drawings.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. NFPA 70 - National Electrical Code

C. UL 5 - Surface Metal Raceways and Fittings

D. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.5 SUBMITTALS

A. Product Data: catalog cuts of components.

B. Shop Drawings:

1. Complete layout, with locations of raceway components.

2. Grounding, branch circuiting and wiring including locations of service entrances.
3. Receptacle types, manufacturers, and spacing.
4. Receptacle labeling with proper voltage, phase, circuit and panelboard designations, as indicated on drawings.
5. Communication faceplate types, manufacturers and labeling.

C. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Closeout Submittals:

1. Project Record Documents

a. Record actual locations of surface raceways with receptacle types, locations and circuits identified.

2. Operation and Maintenance Data:

a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain surface raceways from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

B. Comply with manufacturer’s written instructions.

1.8 WARRANTY

A. Manufacturer shall provide standard one-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metallic Raceways:

1. Mono-Systems
2. Post Glover
3. Square D
4. Wiremold

2.2 FABRICATION

A. UL 5, UL 5A, as applicable.

B. Fabrication:

1. Aluminum.
2. Suitable for use in dry interior locations only.
3. Two-piece with base and snap-on cover.
4. Same size as Wiremold Isoduct ALA 4800 Series.
5. Base: 2 compartments with fixed dividers.
6. 2-compartment raceway with separate cover for each compartment.
7. Covers with cutouts for device plates as shown on drawings.
8. 6" and 12" long device plates with flange to overlap joint of adjacent cover.

C. Prewired Raceways:

1. Wiring devices factory installed, wired, and covers labeled with panel number and circuit number, voltage, phase, and amperes, as identified on drawings, per requirements in Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables and Section 26 2726 - Wiring Devices.
2. Raceway sections with 12" pigtails at feed locations, in 2 ft minimum length and customized to match length shown on drawings.
3. Equivalent distance between receptacles; number of receptacles per length of raceway as shown on drawings.
4. Factory installed, NFPA 70 sized, grounding conductors, per requirements in Section 26 0526 - Grounding and Bonding for Electrical Systems.
5. Raceway covers with hole-cut provisions for communication outlets.
6. Wiring devices on top and communication outlets on bottom.

D. Material:

1. Aluminum Raceways: alloy 6063-T5 extruded aluminum, minimum thickness 0.060".
2. Fittings: same material and metal thickness as linear raceway components.

E. Finish:

1. Aluminum Raceways: Satin, No. 204 clear anodized 0.004"inch thick, Class R1 Mil-Spec.
2. Fittings: color to match linear raceway components.

F. Accessories:

1. Fittings: available as standard accessories, including but not limited to external corner units, internal corner units, flat units, blank end units, internal and external elbows, coupling for joining raceway sections, and device mounting brackets and plates.
2. Wire Clips: one for every 2 linear ft of indicated raceway configuration.
3. Corner elbows and tee fittings, to maintain 2" cable bend radius that meets requirements for communications pathways and specifications for fiber optic, coaxial, and high-performance twisted-pair cabling.
4. Device Mounting Brackets and Plates: plastic device mounting brackets and trim plates allowing installation of indicated wiring devices, and communications outlets horizontally in raceways; trim cover sized to overlap device cut-out in raceway, concealing seams; finished to match linear raceway components; plastic compatible with UL 94; brackets and plates, to match raceway width, and with device mounting holes.

G. Communications Outlets and Accessories:

1. Per requirements in Division 27.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate cover plate openings with wiring devices contained within.

B. Coordinate cover plate openings with communications outlets contained within, to provide for one opening for each communication symbol shown on drawings in Division 27. Coordinate device plate sizes (single-gang or two-gang) to accept communication faceplate types specified in Division 27.

C. Verify with manufacturer that 'touch-up' paint kit is available for repainting.

D. Coordinate surface raceways installation with (laboratory) casework shop drawings to match lengths of cabinets and shelving.

3.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

A. Install in accordance with ANSI/NECA 1 and manufacturer's instructions.

B. Install flathead screws, clips and straps to fasten surface raceways to substrates, ensuring they are permanently and mechanically anchored. Mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Install wiring devices and communications outlets of type, quantity and spacing as indicated on drawings.

D. Mount raceways on wall and casework parallel to or at right angles to structure and casework.

E. Fed raceways mounted on walls, casework or modular casework from backbox through wall box connector. Determine point of feed in field and complete wiring connections.

F. Install chase nipple extension between outlet box on wall and raceway when raceway mounted to support channel for modular casework.

G. Maintain ground continuity throughout entire raceway length per requirements in Section 26 0526 - Grounding and Bonding for Electrical Systems.

H. Do not cut in field prewired raceways.

I. Install appropriate backbox extension rings where raceway is mounted to steel slotted channel or by some other method, stood off from wall.

J. Raceway receptacle faceplates shall be labeled with adhesive labels with 1/4" high lettering, per requirements in Section 26 0553 - Electrical Systems Identification, indicating receptacles voltage, phase, and amperage (i.e., 120V, 1-phase, 20A) at top of receptacle, and panel and circuit designation (i.e., NLP-D2-2/12) at bottom of receptacle, in accordance with requirements in Section 26 0553 - Electrical Systems Identification.

K. Reinforce each cover section for every 30A receptacle in raceway with two 4-40 Phillips counter-sunk steel screws attached to enclosure near top and bottom of receptacle.

L. Identify communication outlets per requirements in Division 27.

M. Raceway base shall be secured using screws. Securing with double-sided adhesive is not acceptable.

3.4 FIELD QUALITY CONTROL

A. Inspect surface raceways for physical damage and proper alignment.

B. Inspect components, wiring, connections, installation, and grounding.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 260533.13

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. Refer to Div 03 for requirements for concrete.

1.2 DESCRIPTION

A. Provide complete underground duct bank system for electrical and communications distribution as shown on drawings.

1.3 REFERENCE STANDARDS

A. UL 6 - Rigid Metal Electrical Conduit

B. UL 514B - Fittings for Conduit and Outlet Boxes

C. UL 651 - Schedule 40 and 80 Rigid PVC Conduits

D. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

E. ANSI C80-1 - Rigid Steel Conduit - Zinc Coated (GRC)

1.4 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. Provide record drawings of exact ductbank routing at site.

1.5 ELECTRICAL DUCTBANK CONTRACTOR QUALIFICATIONS

A. Following are special requirements for any contractor or subcontractor installing ductbanks, transformer pads, switch pads, and similar facilities that will ultimately be part of its joint electric/telecommunications utility distribution system.

B. Any such contractor or subcontractor shall have either a North Carolina General Contractor's License with a Public Utilities Contractor – PU (Electrical - Ahead of Point of Delivery) or Unlimited License Classification per the North Carolina Licensing Board for General Contractors, Rules and Regulations, North Carolina Administration Code, Title 21; Chapter 12.

C. Any such contractor or subcontractor shall have a North Carolina Electrical Contractor's license, Unlimited classification.

D. All such contractors shall also be able to demonstrate to the satisfaction of the Engineer and/or his or her appointees, through references or prior project work that they have adequate, directly related experience to properly perform the ductbank work requested.

E. The contractor possessing the required license and meeting the experience test described shall perform the work themselves.

PART 2 - PRODUCTS

2.1 CONDUITS

A. Size:

1. 6" nominal for power, unless noted otherwise on the drawings.
2. 6" nominal for communications, unless noted otherwise on the drawings.
3. 1.25” minimum for branch circuits, unless noted otherwise on the drawings.

2.2 MATERIALS

A. Duct Lines:

1. PVC conduit, heavy wall rigid, Schedule 40, listed for underground encased applications.

B. Base and Intermediate Spacers:

1. High impact spacers with horizontal and vertical locking separation of 3" between ducts.

C. Elbows:

1. Material to match conduit
2. Minimum bend radius of 36 inches.

D. Bell Ends:

1. Pre-manufactured system with conduit seals, provision for roughing into the concrete and water stops.

E. Seals:

1. Mechanical interlocking assembly seal of modular synthetic rubber links.

F. Bushings:

1. Groundable steel bushings on all metal conduit.

G. Underground Warning Tapes:

1. 6" wide by 0.004" thick polyethylene film with appropriate label and detectable magnetic strip:

a. “Caution - Electric Line Below"
b. "Caution - Communications Line Below"

PART 3 - EXECUTION

3.1 INSTALLATION

A. Trench and backfill for duct lines in accordance with Division 02.

B. Provide concrete work in accordance with Division 03 - Concrete.

C. Provide with minimum 3000 psi concrete.

D. Install top of duct lines minimum of 36" below finish or as shown on the drawings, grade and pitched for drainage.

E. Install base and intermediate spacer at every coupling point of each duct line for a separation horizontally and vertically per NEC.

F. Encase duct lines in concrete with minimum of 3" of concrete on sides and top and 3.5” on bottom.

G. Duct banks must be laid on undisturbed soil or in compacted and inspected fill.

H. Pitch ducts for drainage from building to manholes to drain to prevent accumulation of water in the ductbank, and shall not have any low points.

I. Place warning tape over duct bank 12" above top of concrete.

J. Place #10 copper tracer wire directly on top of ductbanks, and extend wire into manholes / switches / equipment enclosures where ductbanks terminate.

K. Provide minimum of 5 ft of rigid metal conduit in duct lines entering or leaving buildings or stubbing up above grade unless noted otherwise on the drawings.

L. Provide 5 ft rigid metal conduit at 90o elbows above grade.

M. Install conduits with gradual, sweeping elbows and offsets.

N. Duct lines shall slope to drain to prevent the accumulation of water in the ductbank, and shall not have any low points.

O. Contractor shall proof test all conduits using a metallic mandrel prior to owner acceptance of the duct banks.

P. Provide conduit end bells at transition to pads and manholes.

Q. Provide 3/16" diameter nylon cord in each spare duct.

3.2 FIELD QUALITY CONTROL

A. All ductbank shall be inspected and approved by the State Electrical Inspector, Owner and Designer prior to the placement of any concrete. Additionally, this ductbank shall be mandreled after completion. After a duct line is completed, a standard flexible mandrel shall be used for cleaning followed by a brush with stiff bristles. Mandrels shall be at least 12 inches long and have diameters 1/4 inch less than the inside diameter of the duct being cleaned. If the mandrel does not pull thru, the ductbank shall be corrected.

B. Notify Owner and Designer 72 hrs in advance of duct line concrete pour.

END OF SECTION 260543

SECTION 260553 - ELECTRICAL IDENTIFICATION

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 SUBMITTALS

A. Product data for each electrical identification product.

B. Sample of nameplate for each color scheme.

C. Submit table of proposed language for each nameplate to Designer for approval. Engineer reserves the right to modify identifications prior to order.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

A. Marker System: Manufacturers: Brady USA, Marking Services Inc. (MSI), or Seton.

1. Provide adhesive numeric labels for conductors to identify circuit number.

B. Laminated Plastic Nameplates: ASTM D 790, Type I, cellulose, phenolic-resin-laminate engraving stock, Grade ES-2.

C. Nameplates shall have ½" high lettering minimum.

D. Nameplate material colors shall be:

1. Blue surface with white core for 120/208 volt equipment.
2. Black surface with white core for 277/480 volt equipment.
3. Bright red surface with white core for all equipment related to fire alarm system.
4. Dark red (burgundy) surface with white core for all equipment related to security.
5. Green surface with white core for all equipment related to "emergency" systems.
6. Orange surface with white core for all equipment related to telephone systems.
7. Brown surface with white core for all equipment related to telecommunications systems.
8. Purple surface with white core for all equipment related to TV systems.

E. Fasteners shall be small, self-tapping, stainless steel screws. Provide caps or other approved protection on the ends of the screws to prevent damage to insulation.

F. Embossed, self-adhesive plastic tape is not acceptable for marking equipment.

PART 3 - EXECUTION

3.1 GENERAL

A. Identify equipment as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

3.2 DRY TYPE TRANSFORMERS

A. Signage to be provided at each transformer identifying location of remote disconnecting means (i.e. upstream branch power supply circuit breaker within panelboard) (NEC Art 450.14).

3.3 WARNINGS

A. Provide arc-flash labels per the results of the arc-flash analysis. The arc-flash analysis shall be provided by the engineer. Provide labels warning of arc-flash hazards existing while working on the following energized equipment:

1. Switchboard
2. Panelboard
3. Transformer
4. Automatic Transfer Switch
5. Motor Controllers and VFD's

B. The arc-flash sticker should be orange and shall give the following information:

1. State "ARC FLASH & SHOCK HAZARD" "APPROPRIATE PPE REQUIRED"
2. Equipment type and associated voltage
3. PPE level
4. Working distances (limited approach, restricted approach, prohibited approach)
5. Flash protection boundary
6. Available 3-phase bolted fault current
7. Incident Energy and working distance
8. Flash protection boundary

3.4 IDENTIFICATION

A. Nameplates shall be securely attached to non-concealed junction box covers of the following:

1. Telecommunications Distribution System
2. ≤600V Electrical Distribution Systems
3. Fire Alarm System

B. Engraved laminated phenolic nameplates shall be securely attached to:

1. Switchgear
2. Switchboards
3. Panelboards
4. Automatic Transfer Switches
5. UPS system
6. Motor Starters including VFDs

7. Transformers
8. Each separately mounted disconnect switch or circuit breaker
9. Each device in Switchgear
10. Each device in Switchboards

C. Nameplates shall identify equipment designation or load controlled and/or function and shall be same as indicated on contract documents. Nameplate shall include source of power for each piece of switchgear, switchboard, panelboard, etc. Voltages and Wire/Phase configuration shall be shown on panelboard nameplates.

1. Example: Panelboard
   RP1
   208/120V, 3P, 4W
   FED FROM T-RP1

2. Example: Motor Disconnect Switch
   EF-1 DS
   480V, 3P, 25HP
   FED FROM DP

3. Example: VFD
   CWP-1 VFD
   480V, 3P, 100HP
   FED FROM MDP-1

4. Example: Transformer
   T-RP1
   INPUT 480V, 3P, 3W
   OUTPUT 208/120V, 3P, 4W
   FED FROM DP

D. 4" round, 4" square and 4-11/16" junction boxes concealed above ceilings may be identified with neat lettering on cover with permanent type black marking pen.

E. Motor starter nameplates shall include motor designation, horsepower, voltage and panel designation of power source.

F. Submit identification to Engineer for approval. Engineer reserves the right to modify identifications prior to shop drawing approval.

G. Group conductors as to circuits and arrange in neat manner in pull boxes, cabinets and panelboards. Group, bind together with nylon ties and identify conductors as to feeder or branch circuit. Phase identification shall be consistent throughout system.

H. Identify each conductor of all systems at each panel, pull box and at each outlet with permanently attached, wrap around, adhesive markers.

I. Identification of junction boxes and conductors shall include panelboard, switchboard or motor control center, circuit number, phase, control circuit number or other appropriate number or letter that will expedite future tracing and trouble shooting.

J. Conduit, boxes and enclosures for emergency and fire alarm circuits shall be marked so as to be readily identified as part of emergency system.

K. Conduit and boxes shall be spot painted. Conduit shall be identified to within 6" of box or enclosure. Refer to 2.1.D for color coding.

L. All empty conduit runs and conduit with conductors for future use shall be identified for use by tags with string or wire attached to conduit or outlet and shall indicate where they terminate.

M. 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 above. This includes covers on boxes above lift-out and other type accessible ceilings. Boxes shall be painted prior to installation of conductors / cabling. One half of boxes shall be painted, leaving the remaining half for hand-written identification of equipment served (panel board, circuit number, data, spare, etc.)

N. Identify all electrical service entrance main disconnects per NEC requirements. Each nameplate shall identify the location of the other main disconnects.

O. Nameplates shall be securely attached to equipment with self-tapping stainless-steel screws; if the screw sharp end is protected; otherwise Rivets shall be used.

3.5 ACCESS PANEL IDENTIFICATION

A. Furnish typewritten charts with identification and location of access panels serving equipment and incorporate in O&M Manuals. O&M manuals shall be provided for storage on site.

END OF SECTION 260553

SECTION 260593 - ELECTRICAL SYSTEMS FIRESTOPPING

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.

B. Section 078443 - JOINT FIRESTOPPING

1.2 DESCRIPTION

A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors, and ceilings) including both empty openings and openings containing electrical penetrating items, including but not limited to raceways, cables, cable trays, busways, and wireways.

1.3 REFERENCE STANDARDS

A. ASTM E-814 – Standard Test Method for Fire Tests of Through-Penetration Firestops

B. UL 1479 - Fire Tests of Through-Penetration Firestops

C. UL 2079 - Tests for Fire Resistance of Building Joint Systems

1.4 PERFORMANCE REQUIREMENTS

A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

C. Conform to applicable Code requirements of Authority Having Jurisdiction.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

C. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Material Safety Data Sheets provided with product delivered to job site.

F. Certification of compliance with Building Codes of the State of North Carolina per the NC SCO.

G. Inspection reports

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.

B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.

C. Manufacturer's representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and manufacturer, and UL Label where applicable.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.8 PROJECT CONDITIONS

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least 7 days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by the Designer, local building inspector, and NC SCO Authority Having Jurisdiction.

1.10 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.11 WARRANTY

A. Refer to Division 01 and Section 260000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M (Fire Protection Products Division), Hilti Inc, Tremco (Sealant/Weatherproofing Division), Specified Technologies Inc, RectorSeal Corporation.

2.2 MATERIALS

A. Refer to section 078443 - JOINT FIRESTOPPING for additional requirements.

B. Firestop Products: UL 1479, ASTM E-814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.

C. Firestop Systems: Produced by the same manufacturer.

D. Accessories: Components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Accessories include the following items:

1. Permanent forming/damming/backing materials
2. Temporary forming materials
3. Substrate primers
4. Collars
5. Steel sleeves

E. Fill Materials: Including the following:

1. Firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop mortars, pillows/bags, or a combination of these products to provide a UL-listed system for each application required for this Project; mineral wool backing where specified in manufacturer's application detail.

F. Mixing

1. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.

B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.3 INSTALLATION

A. Comply with "System Performance Requirements" Article in Part 1 and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning—Through-Penetration Firestop System—Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number
3. Through-penetration firestop system designation of applicable testing and inspecting agency
4. Date of installation
5. Through-penetration firestop system manufacturer's name
6. Installer's name

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of the State of North Carolina.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.6 CLEANING

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 260593

SECTION 260801- POWER DISTRIBUTION ACCEPTANCE TESTS

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 DESCRIPTION

A. All tests shall be performed by a qualified technician. All equipment shall be tested in accordance with NETA Acceptance Testing Specifications. All electrical distribution equipment shall be tested in accordance with the manufacturer's written instructions in addition to the tests described in this section. All testing described in this specification is applicable to all equipment and systems installed by the Contractor.

B. It is the purpose of these specifications to assure all tested electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications and to assist in start-up or "pre-commissioning" of other building systems.

C. This Section includes acceptance testing requirements for assessing the suitability for service and reliability of the power distribution system. Inspection and Test Procedures shall comply with NETA.

D. Tests and inspections shall be performed after installation.

E. Tests and inspections shall determine suitability for energization.

F. All electrical systems shall pass tests prior to facility final acceptance.

G. This specification requires contractor to engage services of testing agency or self-perform pending Owner approval of written qualifications.

H. Items to be tested and inspected as follows:

1. 15,000-volt cabling, splices, and terminations.
2. 600-volt cabling.
3. 15kV Pad-Mounted Transformers.
4. 480V Switchgear and Switchboards to include circuit breakers.
5. 480V dry-type transformers.
6. Automatic transfer switches.
7. Generator system.
8. Power metering system.
9. Grounding systems.
10. Thermographic testing and survey of all connections in distribution equipment as listed above.

1.3 REFERENCE STANDARDS

A. ANSI/IEEE C2 – National Electrical Safety Code.

B. ANSI/IEEE C37 – Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses.

C. ANSI/IEEE Std. 43 – IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

D. ANSI/IEEE Std. 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

E. ANSI/IEEE Std. 141 – IEEE Recommended Practice for Electrical/Power Distribution for Industrial Plants (IEEE Red Book).

F. ANSI/IEEE Std. 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).

G. ANSI/IEEE Std. 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).

H. ANSI/IEEE Std. 400 – Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

I. ANSI/IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book).

J. NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

K. NEMA MG1 – Motors and Generators.

L. NFPA 70 – National Electrical Code.

M. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance.

N. NFPA 70E – Electrical Safety Requirements for Employee Workplaces.

O. NFPA 101 – Life Safety Code.

P. NFPA 110 – Emergency and Standby Power Systems.

Q. NIST – National Institute of Standards and Technology.

R. OSHA – Part 1910 – Subpart S – 1910.308 – Special Systems.

1.4 SUBMITTALS

A. Testing agency certified credentials per Section 1.5.

B. Test Reports: Include the following:

1. Summary of project
2. Description of equipment tested
3. Equipment used to conduct the test
4. Loadbank(s) data sheets and proposed connection locations for equipment testing
5. Description of tests
6. Test results, as compared to manufacturers' or industry accepted standards and tolerances
7. Conclusions and recommendations
8. Signature of responsible test organization authority

1.5 QUALITY ASSURANCE

A. Qualifications of Testing Agency:

1. Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.
2. Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.
3. On-site technical person shall be currently certified by the International Electrical Testing Association in electrical power distribution system testing.
4. Testing firm shall use technicians who are regularly employed by the firm for testing services.
5. Testing firm shall submit proof of above qualifications with bid documents when requested.

1.6 CONTRACTOR RESPONSIBILITIES

A. Perform all tests per Designer's direction. Designer shall provide test scripts for normal operation and failure modes for:

1. 480V switchgear system
2. ATS
3. Generator
4. Pad-mounted transformer

B. Perform all additional tests per the CxA direction.

C. Contractor shall provide test power and all load bank(s) required when testing equipment before service energization and coordinate availability of test power with General Contractor after service energization. This Contractor shall provide any specialized test power. Load banks shall be resistive type to test full kVA of equipment within practical limits. Provide a trailer-mounted 2500kW loadbank (minimum size with 50kW capacity increments) to test the MV equipment and LV switchgears similar to Avtron #K580HC-25000. Loadbanks shall be adjustable capacity type similar Load bank(s) internal cooling shall be energized from a separate circuit such that load bank can remain in operation safely if source is temporarily removed. The Contractor shall also be responsible for that separate circuit.

D. Verify all metering using loadbanks and separate calibrated Power Quality Meter (PQM).

E. Coordinate with Construction Manager/Owner/Engineer regarding testing schedule and availability of equipment ready for testing.

F. Obtain short-circuit analysis and circuit breaker coordination study with trip unit settings from Designer for 480V switchgear and implement prior to testing.

G. Notify Owner and Designer 10 days before testing.

H. Prepare test results with comparison to industry and manufacturer's values and tolerances.

I. Assure electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with contract documents.

J. Assure suitability for energization.

K. Any system, material, or workmanship, which is found defective on the basis of acceptance tests, shall be reported.

L. Recommendations for acceptance or rejection shall be given upon consultation of Designer and prior to energizing equipment.

M. Testing firm shall maintain written record of tests and shall assemble and certify final test report.

N. Safety and Precautions:

1. Safety practices shall include the following requirements:

   a. Applicable State and Local safety operating procedures.
   b. Owner's safety practices.
   c. Applicable State and Local safety operating procedures.
   d. Owner’s safety practices.
   e. ANSI/NFPA 70E, Electrical Safety Requirements for Employee Workplaces.
   f. American National Standards for Personnel Protection: Lockout/Target

O. All tests shall be performed with apparatus de-energized unless otherwise noted

1.7 TEST EQUIPMENT

A. Suitability of Test Equipment:

1. Test equipment shall be in good mechanical and electrical condition.
2. Split-core current transformers and clamp-on or tong-type ammeters require careful consideration of the following in regard to accuracy:
3. Position of conductor within core.
4. Clean, tight fit of the core pole faces.
5. Presence of external fields.

   a. Accuracy of current transformer ratio in addition to accuracy of secondary meter.

6. Selection of metering equipment should be based on knowledge of waveform of variable being measured. Digital multi meters may be average or RMS sensing and may include or exclude DC component. When variable contains harmonics or DC offset and, in general, any deviation from a pure sine wave, averaging sensing, RMS scaled meters may be misleading.
7. Field test metering used to check power system meter calibration must have accuracy higher than instrument being checked.
8. Accuracy of metering in test equipment shall be appropriate for test being performed but not be in excess of 2% of scale used.
9. Waveshape and frequency of test equipment output waveforms shall be appropriate for test and tested equipment.

B. Test Instrument Calibration:

1. Testing firm shall have calibration program which assures test instruments are maintained within rated accuracy.
2. Accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
3. Instruments shall be calibrated in accordance with the following frequency schedule:

   a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor

4. Dated calibration labels shall be visible on test equipment.
5. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
6. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.
7. Calibrating standard shall be of higher accuracy than instrument tested.
8. All manufacturers’ written instructions

PART 2 - PRODUCTS

2.1 Not applicable to this Section.

PART 3 - EXECUTION

3.1 PREPARATION

A. Documentation: Contractor shall deliver the following to testing firm, minimum two weeks prior to commencement of testing:

1. Complete set of electrical plans and specifications, with available short circuit indicated on power riser diagrams. Contractor shall obtain short-circuit analysis and coordination study, protective device setting sheet, from Designer and implement settings prior to commencement of testing.
2. Approved submittals and shop drawings of equipment being tested.
3. Pertinent change orders.
4. Evaluation, overcurrent protective device coordination and arc flash studies.

B. Schedule: Notify Owner Designer, Cx Agent, and NCSCO electrical inspector 15 working days prior to performance of any tests.

C. Coordination: Coordinate with Construction Manager/Owner/Designer the testing schedule and availability of equipment ready for testing.

D. Test Power: Provide test power (including specialized) for equipment testing before and after service energization.

3.2 INSPECTION AND TEST PROCEDURES

A. 15,000-volt Conductors and Cables:

1. Visual and Mechanical Inspection:

a. Compare cable data with drawings and specifications.
b. Inspect exposed sections of cables for physical damage.
c. Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.
d. Inspect compression-applied connectors for correct cable match and indention.
e. Inspection for shield grounding, cable support, and termination.
f. Verify visible cable bend meet or exceed ICEA and manufacturer's minimum allowable bending radius.
g. If cables are terminated through window-type current transformers, make an inspection to verify neutral and ground conductors are correctly placed and shields are correctly terminated for operation of protective devices.
h. Visually inspect jacket and insulation condition.
i. Inspect for correct identification and arrangements.

2. Electrical Tests:

a. Perform shield-continuity test on each power cable by ohmmeter method and record value.
b. Perform Very Low Frequency with dissipation factor Tangent Delta (VLF tan delta) withstand test of the system in accordance with IEEE 400.
c. Record wet- and dry-bulb temperatures or relative humidity and temperature.
d. Test each section of cable individually.
e. Individually test each conductor with other conductors grounded. Ground shields.

f. Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method as necessary.
g. Perform a thermal detection test on all medium voltage connections subsequent to energization, preferably in July or August, and prior to the expiration of the one year warranty.

3. Test Values:

a. Shielding must exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 feet of cable.
b. Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
c. Step voltage slope should be reasonably linear.
d. Capacitive and absorption current should decrease continually until steady state leakage is approached.
e. Send copies of the test report to the owner, the engineer, and the CM shall maintain a copy for the final SCO inspection.

B. 600-volt Conductors and Cables:

1. Visual and Mechanical Inspection:

a. Compare cable data with drawing and specifications.
b. Inspect exposed sections of cables for physical damage.
c. Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.
d. Inspect compression-applied connectors for correct cable match and indentation.
e. Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
f. If cables are terminated through window-type current transformers, make an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.
g. Inspect for correct identification and arrangements.
h. Inspect jacket and insulation condition.

2. Electrical Tests:

a. Perform insulation-resistance test using megohm meter. Applied potential to be 1000V DC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.
b. Perform continuity tests to insure correct cable connection.

3. Test Values:

a. Insulation-resistance values should not be less than 50 megohms.

C. Electrical Meters:

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Verify tightness of electrical connections.
d. Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
e. Verify freedom of movement, correct travel and alignment, and tightness of mounting hardware.

2. Electrical Tests:

a. Check calibration of meters at cardinal points.
b. Calibrate watt-hour meters according to manufacturer's published data.
c. Verify instrument multipliers.
d. Electrically confirm current transformer and voltage transformer secondary circuits are intact.

e. Verify all metering is properly connected and functional per the design intent. Verify the web-based central monitoring system is operational.

3. Integrated Tests:

a. Confirm all meters properly map over to BAS system for remote monitoring.
b. Confirm all meters properly communication over network (TCP/IP) to central monitoring station (Leake Building) for Owner's Electric Distribution remote monitoring.

D. 600V Switchgear Assemblies:

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Verify appropriate anchorage, required area clearances, grounding and correct alignment.
d. Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
e. Verify circuit breaker sizes and types correspond to drawings and coordination study as well as to circuit breakers address for microprocessor-communication packages.
f. Confirm correct operation and sequencing of electrical and mechanical interlock systems. This includes the mechanical key interlock system and the electrically operated breakers (where applicable).
g. Inspect control power transformers.
h. Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
i. Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.

2. Electrical Tests:

a. Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
b. Perform insulation-resistance tests in each bus section, phase-to-phase and phase-to-ground for one minute in accordance with Table 1.
c. Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. In the absence of any published data, Table 2 shall apply. Test voltage shall be applied for one minute.
d. Perform current injection tests on the entire current circuit in each section of switchgear.
e. Perform current tests by secondary injection, with magnitudes such that minimum of 1.0 amp flows.
f. Test current at each device.
g. Determine accuracy of meters and calibrate watt-hour meters in accordance with paragraph "Electrical Metering." Verify multipliers.

3. Test Values:

a. Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
b. Compare bus connection resistances to values of similar connections.
c. Insulation-resistance values for bus, shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.
d. Bus insulation shall withstand the over-potential test voltage applied.
e. Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from similar bus by more than 50% of lowest value.

E. Low Voltage Power Circuit Breakers

1. Visual and Mechanical Inspection:
   a. Compare nameplate data with drawings and specifications.
   b. Inspect physical and mechanical conditions.
   c. Confirm correct application of manufacturer's recommended lubricants.
   d. Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.
   e. Verify maintenance devices are available for servicing and operating breaker.
   f. Verify primary and secondary contact wipe and other dimensions vital to satisfactory operation of breaker are correct.
   g. Perform mechanical operator and contact alignment tests on breaker and its operating mechanism.
   h. Verify tightness of accessible bolted bus connections by calibrated torque-wrench method. Refer to manufacturer's instructions or Table 12 for correct torque levels.
   i. Perform thermographic survey in accordance with Thermographic Survey Section.
   j. Check cell fit and element alignment.
   k. Check racking mechanism.
2. Field Testing:
   a. Perform all field testing per the manufacturer’s published start-up requirements.
3. Electrical Tests:
   a. Perform contact-resistance test.
   b. Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
   c. Perform insulation-resistance test at 1000 VDC on control wiring. Do not perform test on wiring connected to solid state components.
   d. Make adjustments for final settings in accordance with coordination study supplied by Owner.
   e. Determine minimum pickup current by primary current injection.
   f. Determine long-time delay by primary current injection.
   g. Determine short-time pickup and delay by primary current injection.
   h. Determine ground-fault pickup and delay by primary current injection.
   i. Determine instantaneous pickup value by primary current injection.
   j. Verify calibration of functions of trip unit by secondary injection.
   k. Activate auxiliary protective devices, such as ground-fault or undervoltage relays, to insure operation of shunt trip devices. Check operation of electrically-operated breakers in their cubicles.
   l. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrically close and trip operations, trip-free, and antipump function.
   m. Check charging mechanism.
4. Test Values:
   a. Bolt-torque levels shall be in accordance with Table 12 unless otherwise specified by manufacturer.
   b. Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25%.
   c. Insulation resistance shall not be less than 100 megohms. Investigate values less than 100 megohms.
   d. Trip characteristics of breakers shall fall within manufacturers published time-current tolerance bands.

F. Low Voltage Molded Case Circuit Breakers

1. Visual and Mechanical Inspection:
   a. Compare nameplate data with drawings and specifications.
   b. Inspect circuit breaker for correct mounting.

c. Check cell fit, element alignment and racking mechanism for draw-out breakers.
d. Operate circuit breaker to insure smooth operation.
e. Inspect case for cracks or other defects.
f. Verify tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
g. Inspect mechanism contacts and arc chutes in unsealed units.

2. Electrical Tests:

a. Perform a contact-resistance test.
b. Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
c. Perform insulation resistance test at 1000 VDC on all control wiring. Do not perform the test on wiring connected to solid state components.
d. Perform adjustments for final settings in accordance with coordination study supplied by Engineer.
e. Perform long-time delay time-current characteristic tests by passing 300% rated current through each pole separately unless series testing is required to defeat ground fault functions.
f. Determine short-time pickup and delay by primary current injection.
g. Determine ground-fault pickup and time delay by primary current injection.
h. Determine instantaneous pickup current by primary injection using run-up or pulse method.
i. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
j. Verify calibration of functions of trip unit by secondary injection.

3. Test Values:

a. Bolt-torque levels shall be as specified by manufacturer.
b. Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25%. Investigate any value exceeding manufacturer's recommendations.
c. Insulation resistance shall not be less than 100 megohms.
d. Trip characteristic of breakers shall fall within manufacture’s published time-current characteristic tolerance band, including adjustment factors.
e. For molded-case circuit breakers, trip times shall fall within manufacturer's published data. Circuit breakers exceeding specified trip time at 300% of pickup shall be tagged defective.
f. For molded-case circuit breakers, instantaneous pickup values shall be within manufacturer's published data.

G. Liquid Filled Transformers:

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition for physical damage, cracked insulators, and tightness of connection.
c. Verify removal of shipping bracing after final placement.
d. Inspect impact recorder prior to unloading, if applicable.
e. Verify alarm, control, and trip settings on temperature and level indicators are as specified.
f. Verify cooling fans and pumps operate correctly and fans and pump motors have correct overcurrent protection.
g. Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.
h. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data or Table 12.
i. Perform thermographic survey in accordance with paragraph “Thermographic Survey.”
j. Verify correct liquid level in tanks and bushings.
k. Perform specific inspections and mechanical tests as recommended by manufacturer.
l. Verify correct equipment grounding.

m. Verify seismic bracing is correct.

2. Electrical Tests:

a. Perform insulation-resistance tests, winding-to-winding and each winding-to-grounding with test voltage in accordance with Table 5. Test duration shall be for 10 minutes with resistance tabulated at 30 seconds, 1 minute, and 10 minutes.
b. Calculate polarization index.
c. Perform a turns-ratio test on no-load tap-changer positions and load tap-changer positions. Verify tap setting is as specified. Verify winding polarities are in accordance with nameplate.
d. Perform insulation power-factor/dissipation-factor tests on windings and correct to 20°C in accordance with test equipment manufacturer's instructions.
e. Perform power-factor/dissipation-factor tests (or hot collar watts-loss tests) on bushings and correct to 20°C in accordance with test equipment manufacturer's instructions.
f. Perform excitation-current tests in accordance with test equipment manufacturer's instructions.
g. Measure resistance of each high-voltage winding in each no-load tap-changer position. Measure resistance of each low-voltage winding in each load tap-changer position, if applicable.
h. If core ground strap is accessible, measure core insulation resistance at 500 VDC.
i. Measure percentage of oxygen in nitrogen blanket.
j. Remove sample of insulating liquid in accordance with ASTM D923. Sample shall be tested for the following:

1) Dielectric breakdown voltage: ASTM D877 and/or ASTM D1816.
2) Acid neutralization number: ASTM D974.
3) Specific gravity: ASTM D1298.
4) Interfacial tension: ASTM D971 or ASTM D2285.
5) Color: ASTM D1500.
6) Visual condition: ASTM D1524.
7) Measure dissipation factor or power factor in accordance with ASTM D924.

k. Remove sample of insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ATSM D3612.
l. Test instrument transformers in accordance with paragraph "Instrument Transformers."
m. Test surge arresters in accordance with paragraph "Surge Arresters."

3. Test Values:

a. Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
b. Insulation-resistance test values at one minute should not be less than values recommended in Table 5. Resistance values to be temperature corrected in accordance with Table 14.
c. Polarization index should be compared to manufacturer's factory test results. If manufacturer's data is not available, acceptance test results will serve as baseline data.
d. Turns-ratio test results shall not deviate more than 0.5% from either the adjacent coils or the calculated ratio.
e. Maximum power factor of liquid-filled transformers corrected to 20°C shall be in accordance with transformer manufacturer's published data. Representative values are shown in Table 3. Compare with test equipment manufacturer's published data.
f. Investigate bushing power factors and capacitances that vary from nameplate values by more than 10%. Investigate any bushing hot collar watts-loss results that exceed test equipment manufacturer's published data.
g. Typical excitation-current test data pattern for three-legged core transformer is two similar current readings and one lower current reading.
h. Consult manufacturer if winding-resistance measurements vary more than 1% from adjacent windings.
i. Consult manufacturer if core insulation is less than one megohm at 500 VDC.
j. Insulating liquid shall comply with Table 4.

k. Evaluate results of dissolved-gas analysis in accordance with IEEE Standard C57.104. Use results as baseline for future tests.

H. Dry Type Transformers (<150kVA):

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify that resilient mounts are free and that any shipping brackets have been removed.
e. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
f. Perform thermographic survey of bolted electrical connections, in accordance with paragraph "Thermographic Survey."
g. Verify that as-lift tap connections are as specified.

2. Electrical Tests:

a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 5. Calculate dielectric absorption ratio or polarization index.

3. Test Values:

a. Bolt-torque levels should be in accordance with manufacturer specification.
b. Insulation-resistance test values at one minute should be in accordance with manufacturer specification.
c. The dielectric absorption or polarization index shall be greater than 1.0 and shall be recorded for future reference.

I. Automatic Transfer Switches:

1. Visual and Mechanical Inspection:

a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Verify manual transfer warnings are attached and visible.
d. Verify tightness of control connections.
e. Perform manual transfer operation.
f. Verify positive mechanical interlocking between normal and alternative sources.
g. Inspect anchorage, alignment, grounding and required clearances.

2. Electrical Tests:

a. Perform start-up testing per manufacturer's written procedures.
b. Conduct testing per Section 263623. Use 100% capacity loadbank for testing.
c. Measure contact resistance.
d. Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendation.
e. Verify settings and operation of control devices.
f. Verify phase rotation, phasing and synchronized operation as required by the application.

3. Test remote communications and alarming.
4. Perform automatic transfer tests:

a. Simulate loss of source 1 power.
b. Return to source 1 power.
c. Simulate loss of source 2 power.
d. Simulate all forms of single-phase conditions.

5. Perform manual transfer tests (at the ATS and remote-control station):
   a. Simulate loss of source 1 power.
   b. Return to source 1 power.
   c. Simulate loss of source 2 power.
   d. Simulate all forms of single-phase conditions.
6. Verify correct operation and timing of following functions:
   a. Normal source voltage-sensing relays.
   b. Time delay upon transfer.
   c. Alternate source voltage-sensing relays.
   d. Automatic transfer operation.
   e. Interlocks and limit switch function.
   f. Time delay and retransfer upon normal power restoration.

J. Grounding System:
1. Per Section 260526.

K. Thermographic Survey:
1. Thermograpic survey shall be performed on all electrical distribution equipment with equipment under rated load. Contractor shall be responsible for manufacturing the rated load for each piece of equipment (i.e. loadbanks).
2. Visual and Mechanical Inspection:
   a. Inspect physical, electrical, and mechanical conditions.
   b. Remove all necessary covers prior to thermographic inspection.
   c. Equipment to be inspected shall include all current-carrying devices.
   d. Provide report including the following:
   e. Discrepancies.
   f. Temperature difference between area of concern and reference area.
   g. Cause of temperature difference.
   h. Areas inspected. Identify inaccessible and unobservable areas and equipment.
   i. Identify load conditions at time of inspection.
   j. Provide photographs and thermogram of deficient area.
3. Test Parameters:
   a. Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1°C at 30°C.
   b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   c. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B-2019, Section 18-16 (Infrared Inspection). Refer to Section 1.6.C for loadbank size requirements.
4. Test Results:
   a. Temperature differences of 1 to 3°C indicate possible deficiency and warrant investigation.
   b. Temperature differences of 4 to 15°C indicate deficiency; repair as time permits.
   c. Temperature differences of 16°C and above indicate major deficiency; repair immediately

3.3 All Testing is to comply with NETA as well as manufacturer's written recommendations and procedures. IF MANUFACTURER DOES NOT HAVE TEST VALUE RECOMMENDATIONS, USE THE FOLLOWING TABLES in Part 4.

PART 4 - POWER DISTRIBUTION ACCEPTANCE TEST TABLES

PRODUCT DATA SHEET 0 - TABLE 1
Test Values
Electrical Apparatus and Systems

Cable Voltage Rating	Installation Test Phase to ground RMS	Acceptance test phase to ground RMS	Acceptance test phase to ground RMS
15,000	18,000	20,000	16,000

TABLE 2
Switchgear Low-Frequency Withstand Test Voltages

Type of Switchgear	Rated kV	Maximum Test Voltage kV ac	dc
Low-Voltage Power Circuit Breaker Switchgear	.254	1.6	2.3
	.508	1.6	2.3
	.635	1.6	2.3
MC (Metal-Clad Switchgear)	4.76	14.0	20.0
	8.25	27.0	37.0
	15.0	27.0	37.0
	27.0	45.0	+
	38.0	60.0	+
SC (Station-Type Cubicle Switchgear)	15.5	37.0	+
	38.0	60.0	+
	72.5	120.0	+
MEI (Metal-Enclosed Interrupter Switchgear)	4.76	14.0	20.0
	8.25	19.0	27.0
	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.2-1993, Paragraph 5.5, Metal-Clad and Station-Type Cubicle Switchgear and C37.20.3-1993, Paragraph 5.5, Metal-Enclosed Interrupter Switchgear, and includes 0.75 multiplier with fraction rounded down.

The column headed "DC Withstand" is given as a reference only for those using dc tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a dc withstand test on ac equipment or that a dc withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making dc withstand tests, the manufacturer should be contacted for recommendations before applying dc withstand tests to the switchgear.

+ Consult Manufacturer

TABLE 7
Molded-Case Circuit Breakers
Values for Inverse Time Trip Test

(At 300% of Rated Continuous Current of Circuit Breaker)

Range of Rated Continuous Current Amperes	Maximum Trip Time in Seconds For Each Maximum Frame Rating1	
	250V	251 - 600V
0-30	50	70
31-50	80	100
51-100	140	160
101-150	200	250
151-225	230	275
226-400	300	350
401-600	----------	450
601-800	----------	500
801-1000	----------	600
1001-1200	----------	700
1201-1600	----------	775
1601-2000	----------	800
2001-2500	----------	850
2501-5000	----------	900

Reproduction of Table 5-3 from NEMA Standard AB4-1996.

1 For integrally fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

TABLE 8
Instantaneous Trip Setting Tolerances for Field Testing
of Marked Adjustable Trip Circuit Breakers

	Tolerances of High and Low Settings	
Ampere Rating	High	Low
Adjustable	+40%	-30%
Non-adjustable	+25%	-25%

PRODUCT DATA SHEET 1 - Reproduction of Table 5-4 from NEMA publication AB4-1996.

For circuit breakers with nonadjustable instantaneous trips, tolerances apply to the manufacturer's published trip range, i.e., +40 percent on high side, -30 percent on low side.

TABLE 12
U.S. Standard

Bolt Torques for Bus Connections

Heat-Treated Steel – Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

Bolt Torques for Bus Connections
Silicon Bronze Fasteners1
Torque (Foot-Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

1 Bronze alloy bolts shall have a minimum tensile strength of 70,000 pounds per square inch.

TABLE 12 (CONT.)

Bolt Torques for Bus Connections
Aluminum Alloy Fasteners2
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

2 Aluminum alloy bolts shall have a minimum tensile strength of 55,000 pounds per square inch.

Bolt Torques for Bus Connections
Stainless Steel Fasteners3
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

3 Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy.
Belleville washers: 302 alloy.

PRODUCT DATA SHEET 2 - TABLE 14
Insulation Resistance Conversion Factors For
Conversion of Test Temperature to 200C

Temperature		Multiplier	
EC	EF	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulations
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.25
30	86	1.98	1.58
35	95	2.80	2.00
40	104	3.95	2.50
45	113	5.60	3.15
50	122	7.85	3.98
55	131	11.20	5.00
60	140	15.85	6.30
65	149	22.40	7.90
70	158	31.75	10.00
75	167	44.70	12.60
80	176	63.50	15.80

TABLE 20
Rated Control Voltages and their Ranges
for Circuit Breakers

PRODUCT DATA SHEET 3 - The maximum voltage is measured at the point of user connection to the circuit breaker [see Notes (9) (10)] with no operating current flowing, and the minimum voltage is measured with maximum operating current flowing.

Rated Control Voltages and their Ranges for Circuit Breakers

Rated Control Voltage (8)	Direct Current Voltage Ranges (1)(2) Volts, dc		Opening Functions All Types	Rated Control Voltage (60 Hz)	Alternating Current (1)(2)(3)(5) Closing, Tripping, and Auxiliary Functions
	Closing and Auxiliary Functions				
	Indoor Circuit Breakers	Outdoor Circuit Breakers		Single Phase	Single Phase
24	---	---	14-28	120	104-127 (4)
48	38-56	36-56	28-56	240	208-254 (4)
125	100-140	90-140	70-140	Polyphase	Polyphase
250	200-280	180-280	140-280		180Y/104-
---	---	---	---	208Y/120	220Y/127
---	---	---	---	240	208-254

Derived from Table 8, ANSI C37.06-2000, AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities.

Rated Control Voltages and their Ranges for Circuit Breakers
Solenoid-Operated Devices

Rated Voltage	Closing Voltage Ranges for Power Supply
125 dc	90 – 115 or 105 – 130
250 dc	180 – 230 or 210 – 260
230 ac	190 – 230 or 210 - 260

Notes:

1. Electrically operated motors, contactors, solenoids, valves, and the like need not carry a nameplate voltage rating that corresponds to the control voltage rating shown in the table as long as these components perform the intended duty cycle (usually intermittent) in the voltage range specified.
2. Relays, motors, or other auxiliary equipment that function as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at a remote location.
3. Includes supply for pump or compressor motors. Note that rated voltages for motors and their operating ranges are covered by ANSI/NEA MG-1-1978.
4. Includes heater circuits.
5. Voltage ranges apply to all closing and auxiliary devices when cold. Breakers using standard auxiliary relays for control functions may not comply at lower extremes of voltage ranges when relay coils are hot, as after repeated or continuous operation.
6. Direct current control voltage sources, such as those derived from rectified alternating current, may contain sufficient inherent ripple to modify the operation of control devices to the extent that they may not function over the entire specified voltage ranges.
7. This table also applies for circuit breakers in gas-insulation substation installations.

8. In cases where other operational ratings are a function of the specific control voltage applied, tests in C37.09 may refer to the "Rated Control Voltage." In these cases, tests shall be performed at the levels in this column.
9. For an outdoor circuit breaker, the point of user connection to the circuit breaker is the secondary terminal block point at which the wires from the circuit breaker operating mechanism components are connected to the user's control circuit wiring.
10. For an indoor circuit breaker, the point of user connection to the circuit breaker is either the secondary disconnecting contact (where the control power is connected from the stationary housing to the removable circuit breaker), or the terminal block point in the housing nearest to the secondary disconnecting contact.
11. Some solenoid operating mechanisms are not capable of satisfactory performance over the range of voltage specified in the standard; moreover, two ranges of voltage may be required for such mechanisms to achieve an acceptable standard of performance.
12. The preferred method of obtaining the double range of closing voltage is by use of tapped coils. Otherwise, it will be necessary to designate one of the two closing voltage ranges listed above as representing the condition existing at the device location due to battery or lead voltage drop or control power transformer regulation. Also, caution should be exercised to ensure that the maximum voltage of the range used is not exceeded.

END OF SECTION 260801

SECTION 260923 - CONVENTIONAL LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM

A. Provide stand-alone line- and low-voltage switches, motion sensors, ambient light sensors, power packs, etc. for manual and automated control of lighting loads as shown on drawings and as required herein.

B. All low-voltage communication is to be analog and non-proprietary.

C. Application: Refer to Sequence of Operations on sheet E601 for areas of scope to include: Level 4 attic, private offices, group study, restrooms, secondary circulation, storage and equipment rooms, and other enclosed spaces as indicated by device type.

1. Level 1 group study rooms utilize conventional dimming devices in conjunction with relay control per 260936.
2. Emergency luminaires as required in these spaces are uncontrolled for 24/7 energization at 100%
3. Refer to Symbols and Abbreviations.

D. General definitions:

1. Switching – intentional cycling of power to lighting equipment intended for multiple cycles per day
2. Dimming – continuous reduction (or increase) in luminaire output with proportionate decrease (or increase) in input power.

   a. Phase dimming: Sinusoidal input power wave is modulation on a leading or trailing edge basis (triac forward-phase or ELV reverse-phase) to reduce light output.
   b. 0-10V dimming: Open dimming protocol in which the dimmer supplies a 0-10V control signal (control source) where 10 is full output and 0 is the minimum dimming level of the dimmer/driver combination utilizing separate control wires.

E. Above ceiling devices such as power packs may not be shown on drawings. Contractor is responsible for all equipment and circuitry required for functions as described, as well as coordinating locations that are accessible for maintenance without adding access doors.

1.2 REFERENCE STANDARDS

A. UL20 - General Use Snap Switches.

B. UL773A - Non-Industrial Photoelectric Switches for Lighting Control.

C. NEMA WD 7 - Occupancy Motion Sensors.

D. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts

1.3 SUBMITTALS

A. Product data for control devices covered herein only shall be submitted under this section apart from luminaires submitted under 265000 for independent review. Conventional control devices submitted under Lighting or other specification sections may not be reviewed. Separating submittal content does not alleviate Contractor from coordinating dimming protocols or electrical and physical characteristics.

B. For other than listed manufacturers in Part 2 of this specification, refer to Specification 016000 for Comparable Product Request Submittal requirements to include itemized compliance with each applicable specification line item.

C. Submit product data for equipment provided under this Section to include, but not limited to:

1. Catalog cut sheet for each item specified under this section.
2. Typical wiring diagrams and risers.
3. Motion sensor coverage diagrams: typical diagrams with a statement from manufacturer's authorized representative accepting coverage by locations shown on contract documents.
4. Programming instructions.

D. Shop drawings may be required showing sensor placement and coverage overlaid on project plans if coverage diagrams are insufficient or manufacturer's authorized representative fails to confirm plan locations.

1.4 WARRANTY

A. Provide a minimum of 5-years warranty for all devices and equipment provided under this specification. If manufacturer's warranty is less than 5 years, an extended warranty must be provided.

B. Warranty period shall begin on date of final acceptance as is required by NC State Construction Office.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Operate in ambient temperature range of 0°C (32°F) to 40°C (104°F).

B. Devices shall be Third Party Listed for loads and voltages as shown on drawings.

C. Devices used for emergency power transfer shall be UL1008 listed; devices used for emergency control bypass shall be UL924 listed.

D. Devices installed in or on finished ceilings shall be white; devices installed in or on finished walls shall be colored to match wiring devices per Section 262726.

E. In-wall devices shall have standard rectangular body for mounting under a decorator style faceplate. All openings shall be covered with devices and matching plates.

F. Devices shall be by manufacturer as noted for each device type. Non-listed manufacturers must submit a specification conformance document indicating compliance with all listed criteria in addition to criteria required by Division 01 for alternate materials.

G. Devices of same type shall be from same manufacturer.

2.2 POWER PACKS

A. Definition: load switching device which transforms line voltage to Class II signal wiring to power low-voltage motion sensors.

B. Application: support of sensors with zoning as shown on plans.

C. Manufacturer: Lutron PP/UPP series or equal by Hubbell Control Solutions (UVPP, UVPPM) or Douglas (Diversa)

D. Latching relay rated for 120-277V, 20A

E. Support both auto-ON operation as traditional occupancy sensor and manual-ON operation with momentary contact switches for use as a "vacancy sensor". Where a single device SKU is not able to support both these functions, furnish both SKUs.

F. Available companion device to expand support for at least 6 motion sensors for coverage of large open areas as indicated on plans.

2.3 LOW-VOLTAGE SWITCHES

A. Definition: a wall-mounted device used in conjunction with a power pack to manually turn lights on or off which is not directly connected to the line-voltage load.

B. Application: Locate per plans (to include multi-location switching) for master control of each space with at least one low-voltage sensor

C. Manufacturer: Hubbell Control Solutions LV series or equal by Lutron (NovaT), Douglas (8700) or manufacturer as approved for Section 26 2726 Wiring Devices.

D. Two- or three-wire, single-button momentary contact type switches suitable for multi-way switching applications

E. Model available to integrate 0-10V dimming (with up/down buttons) for vacancy sensing of a single-zone.

F. LED pilot light status indicator.

2.4 PHOTOSENSORS

A. Definition: a device that measures local illumination and transmits an analog signal to an actuating device correlated to maximum and minimum levels as defined for the device which is used for automated control

B. Application: ambient light sensors as indicated on plans

C. Manufacturer: Lutron or equal by Hubbell, Sensorworx

D. Devices shall operate on 120-277V lighting circuit.

E. Interior devices shall be open-loop type for enabling/disabling automatic functions of other devices. Daylight harvesting is not required under this specification. Refer to section 260936 for daylight harvesting configurations.

F. Accuracy shall be +/- 1% indoors, +/- 5% outdoors.

G. Exterior sensors shall have hood for shielding from direct sunlight; operational temperature range shall be 0 to 120°F (-18 to 48°C).

H. A conduit stem may be required for exterior photocell mounting to achieve required positioning.

2.5 MOTION SENSORS

A. Definition: a device that measures parameters which are consistent with human movement and transmits observed motion to actuating devices as an "occupied" status for automated control.

B. Application: coverage as indicated on plans

C. Manufacturer : Lutron LOS series or equal by Hubbell Control Solutions OMNI or LightOWL series, Douglas (Diversa)

D. Have field-changeable coverage patterns to suit environment. Where coverage patterns are specific to the device SKU, the quantity and placement of devices must be reviewed such that one consistent device can be used for the entire facility.

E. LED status feedback to indicate occupant detection (for each technology) which can be disabled.

F. Utilize adaptive technology with non-volatile memory to automatically adjust settings over a time period of up to 4 weeks with ability to independently override sensitivity and timer to fixed settings.

G. Fail ON in the event of a power or connectivity failure.

H. Support use for manual-ON/auto-OFF "vacancy sensing" with inclusion of a time-out grace period to allow occupancy detection to re-energize lighting load without returning to the manual control device in the event of a false-OFF.

I. Shall be low-voltage wired to a power pack or in parallel with multiple sensors to a common power pack where multiple sensors are indicated in a large open areas or long corridors.

J. Contain isolated relay with normally open, normally closed, and common outputs for use with BMS or other system control options.

K. Ceiling mounted sensors shall operate within ceiling heights of up to 12ft, have a 360° viewing angle, and 40-ft minimum range for "major motion".

L. Wall (or "corner") mount sensors shall have a 2-way swivel mounting arm allowing the flexibility to aim over the coverage area or to mount in ceilings of up to 10ft for asymmetric coverage, hence the "corner" of a room.

M. Wall (or "corner") mount sensors shall operate within mounting heights of 7-10ft, have a minimum viewing angle of 90° for wide view, 40° for narrow view, and a minimum 40-ft range for "major motion".

N. All sensors shall utilize Passive InfraRed (PIR) technology for line-of-sight detection for primary triggering. Features shall include:

1. Temperature compensated dual element sensor and multi element Fresnel lens.
2. Daylight filter to ensure sensor is insensitive to short-wave length waves emitted by sun.
3. Ambient light sensor to prevent automatic-on when sufficient light is available.

O. Secondary technology used for multi-technology shall be ultrasonic or microphonic to provide non-line-of-sight detection to hold lighting on with minimal motion.

P. Multi -technology motion sensors shall have independent sensitivity adjustment.

2.6 SENSOR SWITCH

A. Definition: a line-voltage control unit consisting of a motion sensor and at least one relay with manual operation button to be recessed in a backbox in the place of a traditional switch.

B. Application: per plans

C. Manufacturer: Lutron Maestro or equal by Hubbell Control Solutions (Lighthawk), Douglas (Diversa)

D. Switches shall be completely self-contained control devices for replacement of a standard toggle switch with a ground wire and ground strap, not requiring a neutral. Switching mechanism shall be a latching air gap relay.

E. Incorporate features of technologies as indicated (PIR, U, or MT) for low-voltage motion sensors.

F. Utilize adaptive technology with non-volatile memory to automatically adjust settings over a time period of up to 4 weeks with ability to independently override sensitivity and timer to fixed settings.

G. Include configurable ambient light sensor to prevent automatic-on when sufficient light is present in the space.

H. Have one or two buttons (1 or 2 relays) as indicated with numerical suffice (e.g. PIR1, DT2). Dimming type to always be single-relay (i.e. PIRD)

I. Selectable auto-ON or manual-ON for use as vacancy sensor with inclusion of a time-out grace period to allow motion detection to re-energize lighting load without reverting to manual-ON in the event of false-OFF.

J. Have 170° radial spread pattern with minimum of 20-ft axial sensor coverage for “minor motion”.

K. Be user adjustable to provide manual-ON/auto-oFF or auto-ON/auto-OFF control.

L. For auto-on mode, device to revert to auto-ON when turned off manually.

2.7 DIMMER SWITCH

A. Definition: a line-voltage control unit containing a mechanism to reduce the light output as well as a contact to apply or remove current to a lighting load to be recessed in a backbox in the place of a traditional switch.

B. Application: per plans.

C. Manufacturer: Lutron Diva or equal by Hubbell Control Solutions (Rocker Slide), Legrand (Radiant)

D. Physical requirements:

1. Contain power-failure memory to return to intensity level at time of outage when power is restored.
2. Contain relay to automatically remove power to the load when dimmer is off with air-gap switch integral to device to meet requirements of UL 20. Note that 0-10V dimmers may require a remote relay for removing power to the load.
3. Incorporate filter to minimize interference (RFI) with radio, audio, and video equipment.

E. Performance requirements:

1. Accommodate separate control of intensity (such as a slide) and on/off (such as a rocker switch) with ability to maintain set intensity after cycling power.

2. Provide smooth and continuous IESNA Square Law Dimming Curve throughout driver manufacturer's entire dimming range.
3. Dimming technology shall be 0-10V or phase-dim as required by the load. Phase-dimmers shall be expressly designed for use with solid state sources.
4. Incorporate electronic compensation to prevent lights from momentarily flashing ("pop-on") when dimmer is turned on or off or "flickering" when dimmer is adjusted.

2.8 TIMER SWITCH

A. Definition: a line-voltage control unit with integral timer to remove current to a load after a predetermined time period to be recessed in a backbox in the place of a traditional switch.

B. Application: per plans

C. Manufacturer: Tork SS 400 series or equal by Legrand (TS-400), Hubbell Control Solutions (TD-300)

D. Switches shall be completely self-contained control devices for replacement of a standard toggle switch with a ground wire and ground strap. Switching mechanism shall be a latching air gap relay.

E. Switches shall be digital with LCD count-down display. Multi-button time selectors are not acceptable

F. Rotary/mechanical timer switches are not acceptable.

G. Physical:

1. Mount in double-gang box with single-gang plaster ring.
2. Operate 1200W load at 120V or 277V with no minimum load requirement.
3. Utilize firmware or concealed dip switches for setting default timer.
4. Suitable for wiring in multi-location configuration.
5. Display shall be backlit for visibility in dark areas with countdown accuracy to the minute.

H. Performance:

1. Must be compatible with all electronic ballasts, drivers, and inductive loads. Triac and other harmonics generating devices are not permitted.
2. Optional integrated visible and audible warning to engage multiple times in 5 minutes prior to extinguishing lights.
3. Switch button shall function as on/off switch allowing users to manually turn lights off with a single tap.
4. Allow temporary change of the timer setting without resetting dip switches such as by long-pressing the control button to scroll through options.
5. Time-out period shall be adjustable in increments of not more than 10 minutes up to 1st hour and not more than 30 minutes from 1-12 hours.

I. Standard line voltage toggle switches or momentary contact switches as specified in Specification 262726 may be used to accommodate multi-way operation per manufacturer detail where shown on plans.

2.9 CONTACTOR CABINET

A. Definition: Enclosure consisting of one or more lighting contactors, programming interface, and low-voltage input bus for analog external inputs to initiate on/off control of lighting loads.

B. Application: None

C. Manufacturer: Tork ELC series or equal by Asco, Legrand, or manufacturers as listed in Section 262913

D. Contacts used for emergency circuits shall be normally-closed

E. Integrated astronomic timeclock and calendar

F. Photosensor input

G. Momentary contact switch input

H. Where loads are indicated to be dimmed per plans, dimmer switches are to be installed on the load side of the cabinet for task-tuning purposes only. The ability to dim automatically or remotely or to recall scenes is not a function of this device type.

2.10 WIRELESS DEVICES

A. Wireless devices inherently create a digital system. Refer to section 260936 for requirements.

2.11 EMERGENCY CONTROL DEVICES

A. Are not required under the scope of this specification as all emergency lighting will be energized without control for 24-hour operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices at heights scheduled, and as indicated on drawings.

B. Label all line-voltage devices with panel and circuit number in accordance with section 260553.

C. For all devices located above accessible ceilings, label T-bar with clear adhesive label indicating device type and zone number respective to the room. Example: PP-Z1, PP-Z2 for power packs controlling first zone and second zone, respectively.

D. Install wall devices vertically located as follows:

1. Where located at single-leaf entry doors, locate within 6 in. of latch side of frame. Allow an additional 12 in. where glazing is present.
2. Where located at double-leaf entry doors or entry doors without sufficient space at latch side, locate in nearest wall within 6 in of edge of door swing. Door shall not block access to switch.
3. For unusual entry door configurations or devices not at entry doors, locate per plans.

E. Install ceiling devices as shown on drawings or as recommended by device manufacturer.

F. Ceiling mounted motion sensors shall be located sufficiently remote from supply air diffusers.

G. Install devices plumb, level with finished surfaces and free from blemishes.

H. Verify device locations prior to rough in.

I. Class II wiring shall be electrically isolated from power wiring by a Class II transformer.

J. Provide separate neutral conductor for each dimmer.

K. Wiring shall be in conduit.

L. Adjust and test all devices.

3.2 SETTINGS

A. Communicate status of device settings to commissioning agent upon initial installation and energization and at each point that settings are implemented.

B. Photosensors:

1. Set threshold per sequence of operations and reset per walk-thru with Architect/Engineer/Lighting Designer or Owner's Representative if instructed.

C. Motion sensors:

1. Set to test mode for duration of construction and inspection activities.
2. Reset sensors to automatic adaptation mode except as otherwise indicated in sequence of operations upon beneficial occupancy.
3. Enable ambient light sensor and adjust threshold as noted for Photosensors.
4. Sensor switches:

a. Dual-relay devices shall use factory default auto-ON for relay-1; manual-ON for relay-2.
b. Single-relay devices shall be manual-ON.

D. Dimmer switches:

1. Set high-end and low-end trims per walk-thru with Architect/Engineer/Lighting Designer or Owner's Representative where directed.

E. Timer switches:

1. In closets 120 sq. ft. or less, time delay to be set to 15 minutes; audible warning only enabled.
2. In storage rooms greater than 120 sq. ft. and less than 300 sq. ft., time delay to be set at 30 minutes; audible and device visual warning enabled.
3. For spaces greater than 300 sq. ft., time delay to be set at 2 hours; all warnings shall be enabled.

F. Refer to Sequence of Operations on sheet E601 for supplemental instruction in specific spaces.

3.3 TESTING

A. Verify dimmers function without producing lamp flicker or audible noise. Troubleshoot and correct per manufacturer's recommendations.

B. Verify dimmers function without interference of audio and visual equipment.

C. Adjust occupancy sensors to walk-test mode for testing.

D. Verify proper operation of sensor switches.

E. Adjust motion sensors by aiming or masking such that movement outside range of coverage (e.g. beyond the door or end of corridor) shall not trigger sensor.

3.4 MANUFACTURER SERVICES

A. Performance Verification:

1. Walk through systems with commissioning agent to demonstrate control device configuration meets design intent.
2. Review system settings with Owner and adjust as necessary to optimize performance.
3. Provide documentation that systems were thoroughly tested.

B. Training:

1. Provide up to four hours to review device functions, settings, and troubleshooting with UNCW facilities staff.
2. Furnish O&M manuals for reference (hard copy and/or electronic version on tablet) during training.

C. Post-Occupancy:

1. Arrange visit approximately 6 months after owner occupancy to trouble-shoot any user complaints.
2. Review installation and settings in respect to optimized energy savings.
3. Adjust settings and advise owner on environmental deficiencies such as sensor placement.
4. Contact owner 6 months later (12 months total) to review owner satisfaction.

END OF SECTION 260923

SECTION 260936 – MODULAR DIGITAL LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF SYSTEM

A. Provide intelligent zone controllers, keypads, occupancy sensors, ambient light sensors, etc. as shown on drawings and as required herein as distributed devices or packaged into a central enclosure connected on a digital control bus for switching and dimming control of lighting loads.

B. Application: Lobbies, meeting spaces, open plan shared work spaces, etc. per Sequence of Operations on sheet E-601 and as indicated by device type per symbols and abbreviations.

C. General definitions:

1. Switching – intermittent cycling of power to lighting equipment intended for multiple cycles per day
2. Dimming – continuous reduction (or increase) in luminaire output with relative decrease in input power, frequently achieved by constantly cycling the light engine faster than the eye can perceive.
   a. Phase dimming: Sinusoidal input power wave is modulated on a leading or trailing edge basis (triac forward-phase or ELV reverse-phase) to reduce light output. Switching and dimming are controlled by the same device (dimmer).
   b. 0-10V dimming: Open, analog dimming protocol in which the dimmer supplies a 0-10V control signal (control source) over dedicated wiring where 10 is full output and 1 is the approximate minimum dimming level of the dimmer/driver combination. Dimming and switching may be independently controlled.
   c. Digital Addressable Lighting Interface (DALI): Open dimming protocol in which a control bus operates a two-way communication signal loop with digital devices (drivers, sensors, keypads, etc.) which allows each component to be addressed for individual functioning set via software. Proprietary versions of this protocol are also acceptable where luminaire drivers are coordinated.
   d. Digital Multiplex (DMX512, “DMX”) is an open protocol for digital communication networks originating with theatrical lighting and effects. DMX is required for control of all dynamic content as indicated in the sequence of operations on sheet E-601 and is an acceptable alternative to DALI where luminaire drivers are coordinated.
3. Stand-Alone – Functionally independent from other building systems without reliance upon a remote processor, BAS, LAN, or Internet for settings or logic sequencing.
4. System controller – programmable device capable of some level of conditional logic to receive input data (such as occupancy status or button press) and output a control command (such as switching or dimming)
5. Control bus – Class II wiring carrying data between system controllers and input devices
6. Control Segment – the connected system controllers, input devices, and control bus required to enable functions of a given space (or grouping of similar adjacent spaces) as described herein or within the Sequence of Operations.
7. Dynamic content – A collection of lighting features (e.g. intensity, color, etc.) which automatically transition over time.

D. Conventional power packs, dimmer switches, sensor switches, etc. are not covered in this specification. Refer to section 26 0923 for these devices and apply per the sequence of operations matrix.

1.2 REFERENCE STANDARDS

A. UL20 - General Use Snap Switches.

B. UL773A - Non-Industrial Photoelectric Switches for Lighting Control.

C. UL924 – Standard for Emergency Lighting and Power Equipment

D. UL1008 – Transfer Switch Equipment

E. NEMA WD 7 - Occupancy Motion Sensors.

F. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts

1.3 SUBMITTALS

A. Conventional power packs, dimmer switches, sensor switches, etc. are not covered in this specification and are not to be included in submittal. Refer to section 260923 for applicable submittal procedures.

B. For other than listed manufacturers in Part 2 of this specification, refer to Specification 016000 for Comparable Product Request Submittal requirements to include itemized compliance with each applicable specification line item of Part 2 and manufacturer services in Part 3.

C. Prior to the pre-construction meeting noted in Part 3 of this specification, submit the following for review-only:

1. Specification conformance document:

a. Letter from Manufacturer's Authorized Representative that the construction documents have been reviewed noting any exceptions to:

1) Functional intent,
2) Sensor placement and coverage,
3) Supplemental power requirements beyond that shown on plans,
4) Other aspects of the design pertinent to installation, operation, and/or maintenance.

b. Line-item review of Part 2 of this specification noting any points of deviation or necessary clarification.

c. Absence of this document will delay execution of the pre-construction meeting and subsequent product and system approvals.

2. Bill of Materials: All devices to be part of the system regardless of source (ex. Third party sensors or UL924 bypass devices) shall be listed and formatted with:

a. Manufacturer's part number
b. Manufacturer's verbal description
c. Corresponding symbol or description as used in the contract documents

3. Riser diagrams with devices labeled with part number and project-specific identifier, e.g. "LRC-1"
4. Product data sheets for all devices in the bill of materials in the order listed.
5. Resume for field-service technician assigned to project indicating history with the company, total relevant work history and means of contact (email or mobile phone number). To comply with applicable privacy laws or policies, personal details may be withheld.

D. Following the pre-construction meeting, resubmit review materials with corrections and updates adopted during the meeting for approval. Submit:

1. Items 1-5 from review-only submittal.
2. Site-specific wiring diagrams: Where standard details from product literature are to be applied, such diagrams shall be circled or highlighted within the data sheet and correlated by reference to sequence of operations sequence ID and/or room numbers to the application.
3. Floorplan drawings: Obtain the most up-to-date project plans to overlay manufacturer's device types with installation and wiring notes germane to the installer's scope of work. Provide a symbol legend to be consistent with the bill of materials. Scope associated with conventional control devices should not be shown or should be grayed out if needed for reference.

E. Proofs: Following approval of the Product Data and Shop Drawings, submit the following:

1. Keypad button engraving templates for all keypads with more than 3 buttons.
2. Where touch screens are furnished, provide a proof (screenshot) indicating the home page and each additional page connected by arrows indicating the flow noting available customization options.
3. Proofs may be generic in nature. Specific count and configuration and labeling of buttons, sliders, etc. specific to this project are not required until O&M submission.

F. All submittal materials shall be submitted in electronic PDF format with bookmarks for each submittal item noted above and for each product data cut sheet labeled to correspond with the bill of materials. Bookmarks are to reflect page headings or product types not merely page numbers. Submittals which do not include functional bookmarks are subject to return without review.

G. Sample devices may be required to verify user interface or architectural features.

1.4 WARRANTY

A. Provide a minimum of 5-years warranty for all devices and equipment provided under this specification. If manufacturer's warranty is less than 5 years, an extended warranty must be provided.

B. Warranty period shall begin on date of final acceptance as is required by NC State Construction Office.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Operate in ambient temperature range of 0°C (32°F) to 40°C (104°F).

B. Devices shall be Third Party Listed for loads and voltages as shown on drawings.

C. Systems shall be BTL Certified for BACnet integration.

D. Devices used for emergency power transfer shall be UL1008 listed; devices used for emergency power bypass shall be UL924 listed.

E. Devices installed in or on finished ceilings shall be white; manual control devices installed in or on finished walls shall be colored to match wiring devices per Section 262726.

F. All openings shall be covered with devices and matching plates.

G. Control bus shall be topography-free, non-proprietary, Class II unshielded twisted pair.

H. Manufacturer:

1. Basis of Design: Lutron Athena
2. Other acceptable manufacturers subject to compliance with requirements: ETC, Douglas

2.2 ZONE CONTROLLERS

A. Definition – distributed system controller containing a relay with terminals for dimming control wiring.

B. Application – not applicable, for reference only. See ROOM CONTROLLERS

C. Physical requirements:

1. Controllers shall mount to a ½" electrical junction box knock out using a thread nipple and retaining nut with available barriered enclosure to accommodate installation of Class 2 wiring in conduit. Enclosure shall be plenum-rated.
2. Controllers shall support a power input range from 120 through 277 VAC, 50/60Hz (utilizing lighting or plug-load power circuit) with fully rated 20A outputs and independent 0-10V control per channel.
3. Firmware is to be upgradeable by means such as USB, Micro SD slot, or similar removable media.

D. Functional requirements:

1. Basic programming changes shall be supported from on-board pushbutton controls with LED indicator per channel without the use of software or specialty tools. All buttons shall be fully accessible when the Controller is installed.
2. Controllers shall support automatic configuration to the most energy-efficient control scheme based on other devices installed on the control segment and support manual or automatic-on of one or both zones.
3. Upon loss and subsequent return of power, Controllers shall return to their last state.
4. Controllers shall communicate with up to 16 input devices and 15 additional system controllers installed on the control segment. Each control segment shall be capable of stand-alone control.

2.3 ROOM CONTROLLER

A. Definition – distributed system controller containing 4 or more zone controllers integrated into a single plenum-rated enclosure with on-board accessories and input terminals for use as a package solution for a complex space or a bank of independently functioning single-zone spaces.

B. Application – Large, multi-zone spaces and as indicated on Sequence of Operations matrix.

C. Basis of Design: Lutron ESN

D. Physical requirements:

1. Self-contained in a plenum-rated enclosure no larger than 12" x 14" x 4" (4 zone models) with removeable dead-front cover.
2. Available in a minimum of 4-zone configurations with a 20A, fully–rated, relay output and 0-10V dimming output per zone with additional models or adapters for DALI or phase dimming as required by luminaires.
3. Each relay terminal shall accept #6-14AWG wire and be clearly labeled Input, Output and Thru supporting a single power input to multiple discrete relays, in any combination.
4. Contain internal voltage barriers to separate Class 1 and Class 2 wiring
5. Models with more than 4 zones shall be available with voltage barriers to separate normal and emergency circuits or lighting and plug load circuits.

6. Include integral power supply served by 120-277V lighting circuit to provide control bus power for at least six wall control stations
7. Integral RJ-45 port for laptop plug-in.

E. In addition to functional requirements of zone controllers, room controllers shall:

1. Support a dry contact input to trigger a preset, play back a sequence, trigger room combine, or any other system contact input function
2. Support use in UL 924 Emergency Systems with optional 20A single-phase sense feed and dry contact input for triggering of an emergency condition
3. Include real time and astronomic timeclock

F. Room controllers serving the same space shall be connected to a common control bus to form a single control segment.

G. Control segments shall be joined to the nearest lighting relay panel for sharing of project parameters such as timeclock events, and Internet access for push firmware updates and web-based software interface but each control segment shall remain capable of stand-alone operation.

2.4 LIGHTING RELAY PANEL

A. Definition – system controller with multiple relays and dimmers integrated as an assembly on wall-mounted strut system to include processor suited for primarily time-based control, but also capable of keypad, sensor, and 3rd-party interface-based input processes.

B. Application – lobbies, major circulation spaces, building exterior, site as indicated in Sequence of Operations matrix.

C. Basis of Design: Lutron Athena QS DIN Rail Panel

D. Physical requirements:

1. A relay panel shall be feed-thru type consisting of a minimum of (8) 20A relays and control electronics in a single wall-mountable enclosure with a footprint of not more than 20” wide and 6.5” deep with lockable cover.
2. Equally sized top, bottom, and side removable knockout panels shall facilitate conduit entry, with an internal pass-through plenum for side-by-side or top-to-bottom mounting. The front panel shall be easily removable as well for full front access to input, output, and data connections.
3. The panel control electronics shall operate on single phase, two wire + ground, 120V or 277V AC 60Hz, at an amperage sufficient to power the panel (8 amps max) and supply station power to connected interface devices.
4. A voltage barrier shall be available to separate relays carrying normal and emergency power in the same panel. Panel shall be suitable for a minimum of 2 barriers to be installed between any two relays.
5. Each relay shall have an integral manual override switch with on/off status indication.
6. The relays shall have the following minimum ratings:
   a. 14,000A Short Circuit Current Rating at 277V
   b. 1500A short circuit current
   c. 5000V RMS isolation
   d. 1,000,000 cycles electronic
7. The enclosure shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable
8. Integral RJ-45 port for laptop plug-in.

E. Functional requirements:

1. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay per relay using a period of 0.1 to 60 seconds, in 0.1 second increments
2. Available 0-10V dimming shall link each of the 0-10V outputs with a relay circuit in the panel. Each output shall sink up to 50 mA of current for control of at least 50 LED drivers.
3. Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing and cannot assign each 0-10V output control to any internal relay shall not be acceptable
4. Ability to record up to 16 presets in each space for recall from the control panel, connected control stations, or timed events
5. Support adjustable fade rates of 0-300 seconds between scenes depending upon the input.
6. The panel shall bear a UL924-listing for control bypass use in Emergency Lighting systems.
7. The relay panel shall allow the activation of presets, sequences, and zone programming of up to 50 timeclock events via a built in real and astronomical timeclock supporting event override and timed event hold.
8. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle.
9. Upon Data loss the system shall provide options to hold last scene infinitely or hold for a configured time period set in the field with fade to the input of the next available priority.
10. After power loss, electronics shall be capable of holding the system in its previous state until new level data is received to make each relay change state.

F. Relay panels shall be joined on common control bus for sharing of project parameters such as timeclock events, and Internet access for push firmware updates and web-based software interface but, but each panel shall remain capable of stand-alone operation.

2.5 DIGITAL SHOW CONTROLLER

A. Not applicable to project scope.

2.6 SENSORS

A. See also Paragraph 2.10 WIRELESS DEVICES for wireless requirements.

B. Use of these devices may overlap in functionality with sensors furnished under 260923. Refer to Sequence of Operations matrix for application.

C. Photosensors (ambient light sensors, photocells):

1. Basis of Design: Lutron CES sensor with LC8 controller
2. Measure local illumination condition and transmit analog signal to system interface device correlated to maximum and minimum levels as defined for the system.
3. Interior photocells shall support daylight harvesting control logic
4. Accuracy shall be +/- 1% indoors, +/- 5% outdoors.
5. Exterior photo sensors shall have hood for shielding from direct sunlight; operational temperature range shall be 0 to 120°F (-18 to 48°C).
6. A conduit stem may be required for exterior photocell mounting to achieve required positioning.

D. Motion Sensors:

1. Basis of Design: Lutron LOS series
2. All sensors shall utilize Passive InfraRed (PIR) technology for line-of-sight detection for primary triggering. Features shall include:
   a. Temperature compensated dual element sensor and multi element Fresnel lens.
   b. Daylight filter to ensure sensor is insensitive to short-wave length waves emitted by sun.
   c. Ambient light sensor to prevent automatic-on when sufficient light is available.
3. Secondary technology used for dual technology sensors shall be ultrasonic or microphonic to provide non-line-of-sight detection to hold lighting on with minimal motion.
4. Dual- technology occupancy sensors shall have independent sensitivity adjustment.
5. Field-changeable coverage patterns to suit environment. Where coverage patterns are specific to the device SKU, one consistent device must be used for the entire facility.
6. LED status feedback to indicate occupant detection which can be disabled.
7. Adjustable time delays from 30 seconds to 15 minutes and adjustable sensitivity.
8. Fail ON in the event of a power or control bus connectivity failure.
9. Be low-voltage wired to the system controller.
10. Be low-voltage wired on the control bus where multiple sensors are indicated to control a large area.
11. Contain isolated relay with normally open, normally closed, and common outputs for use with BMS or other system control options.
    a. Alternatively, coordinate with BMS contractor to provide occupancy data via contact closure per HVAC control zone at the system controller, either directly or via interface device.
12. Ceiling mounted sensors shall operate within ceiling heights of up to 12ft, have a 360° viewing angle, and 40-ft minimum range for “major motion”.
13. Wall mount sensors shall operate within mounting heights of 7-10ft, have a viewing angle of 140° for wide view, 40° for narrow view, and a minimum 60-ft range for “major motion”.
14. Wall mount sensors shall have a 2-way swivel mounting arm allowing the flexibility to aim over the coverage area or to mount in ceilings of up to 10ft for asymmetric coverage.
15. Support use as a “vacancy sensor” for manual-on application as a default.

2.7 DIGITAL KEYPADS/USER INTERFACE DEVICES

A. See also Paragraph 2.10 WIRELESS DEVICES for wireless requirements.

B. Basis of Design: Lutron SeeTouch QS

C. Operate on control bus and be powered by control bus power supply.

D. Keypad shall fit under standard decorator wall plate installed flush to wall with no visible means of attachment

E. Faceplates shall be indelibly marked for each button or fader function.

F. The station shall have an integral pilot light for each corresponding button and fader indicating status.

G. Keypads shall operate using 1-7 buttons for scene selection, zone toggle, or dimming function as required by Sequence of Operations matrix.

H. Wiring termination connectors shall be provided with all stations.

I. Touchscreen: supply a touchscreen in multi-gang backbox where functionality cannot be contained within a single keypad or separate functions can be combined at one location such as control of both lights and shades.

1. Basis of Design: Lutron Athena Touchscreen
2. Suitable for programming scenes and timeclock events in addition to scene selection and dimming.
3. Physical requirements:

   a. A touchscreen shall consist of a backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels with a capacitive multi-touch interface.
   b. Operate on POE or internal power supply for input at 120VAC, 60 Hz
   c. Mount flush to industry standard back box
   d. The unit shall have connection terminals for control bus wiring.

4. Scene selection shall be accessible from the home screen.
5. Multi-level password (or PIN) protection shall be supported to protect programming and control access beyond the designated area.

2.8 LIGHTING MANAGEMENT HUB

A. Basis of Design: Lutron Athena QP5

B. Control, manage, and monitor system controllers and input devices with integral processor

1. Supports connection to wired devices; supports connection to processors and wireless gateways via control bus (system Ethernet link).
2. Supports internet connection for automated firmware updates and remote access, diagnostics, and service.
3. Connects to controls via RS485.
4. Integrates control station devices, shades, and external inputs into single customizable lighting control system with automatic control, manual overrides, and multiple failsafe mechanisms:

   a. Power failure detection via emergency lighting interface.
   b. Protection: Lights go to full on if driver wires are shorted.
   c. Distributed architecture provides fault containment. Single hub failure or loss of power does not compromise lights and shades connected to other lighting management hubs.

C. On-board 8-port Ethernet POE switch

D. Internal power supply

E. Internal timeclock for astronomic and time-of-day scheduled events

F. Non-volatile memory to maintain programming through extended power outages

G. BACnet:

1. Provide ability to communicate by means of native BACnet IP communication (does not require interface) to lighting control system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
2. Requires only one network connection per system.
3. The BACnet integrator can command:

   a. Area light output.
   b. Master load shed enable/disable.

4. The BACnet integrator can monitor:
   a. Area on/off status.
   b. Area occupancy status.
   c. Master load shed status.
5. Option: BTL Certification for direct mapping of control points to building automation system via BACnet.

H. Enclosure: NEMA listed enclosure of approximately 15-in wide by 4-in deep with terminal blocks listed for field wiring to be wall-mounted in proximity to lighting relay panel. Alternatively, hub components may be housed within lighting relay panel enclosure.

I. Software-based programming interface consisting of a mobile or desktop application (Windows, Apple iOS, and Android compatible) is required to access the control segment in one of the following ways:
   1. Web-based software accessible by modern browser requiring only Internet connection. Access to LAN shall not be required.
   2. A hard-wired RJ45 port for laptop plug-in

2.9 THIRD PARTY INTEGRATION

A. For spaces indicated in Sequence of Operations (SOO) to have AV integration required, provide RS232 interface or other means acceptable to AV Contractor to receive commands from the AV system.

B. Provide contact closure output, RS232, or Ethernet interface for signaling motorized shades and screens. Screen control to be up/down only with jogging and presets available for shades. Coordinate control equipment with shade manufacturer prior to submittal phase.

C. UL924 listed emergency bypass equipment with sense feed and input from fire alarm system for triggering emergency condition to drive lighting to full output.

2.10 WIRELESS DEVICES

A. Wireless communication in place of a control bus is acceptable only if the Owner's IT department provides written acceptance of the system for devices within the same room.

B. All functional requirements of the proposed device to be furnished must be met.

C. Wireless wall control stations shall utilize line-voltage wiring for power and be available in the same finishes with similar aesthetic to manufacturer's wired devices

D. Additional devices such as modules to integrate wireless components to a wired control segment must be coordinated by the contractor to be inconspicuously located but clearly identifiable without impeding access to other building systems.

E. Battery-powered devices:
   1. Battery-powered devices are only acceptable as an installation cost savings with a credit to be provided to the contract.
   2. Battery-powered devices must contain low-battery warning feature and utilize battery types readily available at most major hardware and convenience stores and shall be covered by a minimum 10-year warranty.
   3. Battery-powered devices are not permitted in ceiling sensors or wall sensors installed at greater than 4-ft above finished floor.

PART 3 - EXECUTION

3.1 PRE-CONSTRUCTION MEETING

A. Following the initial review submittal, the Contractor shall meet with lighting equipment supplier, lighting control equipment supplier, Owner and Designer to establish the compatibility requirements prior to submitting shop drawings for approval.

B. The agenda for this meeting shall include at minimum:

1. Specification Conformance Document: Review exceptions and proposed alternate compliance methods.
2. Dimmer-driver compatibility: verify the proposed dimming technology and driver type as well as implications for installation and wiring. Note that at minimum a draft of the luminaire submittal package must precede this meeting.
3. Equipment locations: Guidelines for equipment access and room locations for wall-mounted equipment.
4. Sequence of operations: Review the matrix and clarify the intent with Designer and Owner.
5. Integration: All systems which may require outputs from the lighting control system such as AV, shades, BAS should be reviewed with follow-up to the appropriate Contractor/Vendor.

C. No submittal approval will be provided until this meeting is executed.

3.2 INSTALLATION

A. Install devices at heights scheduled, and as indicated on drawings.

B. Install wall devices vertically located as follows:

1. Where located at single-leaf entry doors, locate within 6-inches of latch side of frame. Where side-light glazing is present, locate adjacent to glazing frame.
2. Where located at double-leaf entry doors, locate within 6-inches of inactive leaf frame.
3. Where located at double-leaf entry doors which ae both active or single-leaf entry doors without sufficient space at latch side, locate in nearest wall within 6 in of edge of door swing. Door shall not block access to switch.
4. For unusual entry door configurations or devices not at entry doors, locate per plans and elevations.

C. Install ceiling devices as shown on drawings or as recommended by device manufacturer.

D. Ceiling mounted occupancy sensors shall be located sufficiently remote from supply air diffusers.

E. Install devices plumb, level with finished surfaces and free from blemishes.

F. Verify device locations prior to rough in.

G. Provide separate neutral conductor for each dimming circuit.

H. Wiring shall be in raceway.

I. Adjust and test all devices.

J. Labeling: Provide labels in accordance with section 260553 as follows:

1. Power-input control gear such as processor cabinets, relay panels, room controllers, power supplies, etc.

   a. Unique equipment designation per manufacturer's approved shop drawings
   b. Room number of equipment location
   c. Panel and circuit number of line-voltage feed

2. Provide directories for multi-channel control gear such as relay panels and room controllers with descriptors to be approved by the Owner.
3. Digital keypads and peripherals shall be labeled inconspicuously (such as the inside of the device faceplate) with device address.
4. For all devices or equipment located above accessible ceilings, label T-bar with clear adhesive label and equipment ID per approved shop drawings.

3.3 TESTING

A. Check dimmer preset control for proper operation.

B. Verify dimmers function without producing lamp flicker or audible noise. Troubleshoot and correct per manufacturer's recommendations.

C. Verify dimmers function without interference of audio and visual equipment.

D. Adjust occupancy sensors to walk-test mode for testing.

E. Verify proper operation of occupancy sensor switches and by-pass switches.

F. Adjust motion sensors by aiming or masking such that movement outside range of coverage (e.g. beyond the door or end of corridor) shall not trigger sensor.

3.4 MANUFACTURER COMMISSIONING SERVICES

A. Provide factory-certified field service technician to make site visits to ensure proper system installation; technician qualifications are as follows:

1. Minimum experience of 2 years employment with the manufacturer in field service role.
2. Certified by the equipment manufacturer on the system installed.

B. Pre-wire site visit: Review system wiring installation and equipment rough-ins in progress with respect to submittal drawings and advise Contractor of potential problems. This visit may be performed by manufacturer's authorized personnel.

C. On-Site Start Up:

1. Verify connection of power feeds and load circuits.
2. Verify connection and location of wall stations.
3. Check load currents and remove by-pass jumpers.
4. Verify system operation control by control, circuit by circuit.
5. Verify proper operation of manufacturers interfacing equipment.
6. Develop IDs for system components and relay device ID methodology to building automation contractor.
7. Obtain sign-off on system functions.

D. Scene and Level Tuning:

1. Set system dimming levels based on control intent using a light meter calibrated within last 12 months.
2. Arrange walk-through visits with Owner's designated personnel (users) to fine-tune and develop appropriate additional scenes for system presets.
3. User interface devices shall have button configuration and programming complete in accordance with contract documents with revisions per shop drawing review process for initial review by users.
4. Incorporate revisions following user walk-through and provide final engraved buttons.

E. Performance Verification:

1. Walk through systems with commissioning agent to demonstrate control system meets design intent
2. Review system settings with Owner and adjust as necessary to optimize system performance
3. Provide documentation that systems were thoroughly tested

3.5 MANUFACTURER POST-COMMISSIONING SERVICES:

A. On-Site Training:

1. Schedule training with Owner to occur within 3 months of substantial completion.
2. Coordinate with Owner to provide 1-2 weeks advance scheduling. If less than 1 week of notice is given and the Owner is unable to provide the essential personnel for training, the training shall be rescheduled or repeated at the Owner's convenience.
3. Provide for a minimum of 1/2 hour of training for each installed device type for Owner's designated representatives following substantial completion. Training shall cover, but not be limited to, the following:

   a. Device features and functionality
   b. Settings and programming
   c. Default settings and modifications specific to the project
   d. Maintenance requirements and basic trouble-shooting
   e. Technical support availability
   f. Warranty terms and conditions including optional services or extended warranties offered

4. Furnish O&M manuals for reference (hard copy and/or electronic version on tablet) during training.

B. System Optimization (post-occupancy):

1. Arrange visit approximately 6 months after system turnover to trouble-shoot any user complaints.
2. Review installation and settings in respect to optimized energy savings.
3. Adjust settings and advise owner on any environmental deficiencies such as sensor placement
4. Contact Owner 6 months later (12 months after system turnover) to review owner satisfaction.

3.6 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.

B. Provide factory support of system for a minimum of ten years from the date of manufacture by way of online technical support and live technical support by phone.

C. Newly fabricated replacement parts shall be manufactured which are physically, electrically, and functionally compatible.

D. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits.

1. Make service contracts available up to ten years after date of system commissioning.
2. Make available on-site service support within 24 hours to the job site

END OF SECTION 260936

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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 DESCRIPTION

A. This Section includes dry type distribution and buck-boost transformers rated 600 volts and less, with capacities up to 150KVA.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. IEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NEMA ST 1 - Specialty Transformers (except General Purpose Type)

E. NEMA ST 20 - Dry-Type Transformers for General Applications

F. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers

G. NEMA TP 2 - Test Method for Measuring the Energy Consumption of Distribution Transformers

H. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

I. NFPA 70 - National Electrical Code

J. UL 506 - Specialty Transformers

K. UL 1561 - Dry-Type General Purpose and Power Transformers

L. US Code of Federal Regulations Title 10 CFR Part 431 Efficiency Standards for Transformers

1.4 SUBMITTALS

A. Product Data:

1. Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings:

1. For each transformer size and type:

a. Physical dimensions, including bolting templates, weight and center of gravity
b. Loads, method of field assembly, components, and location and size of each field connection

c. Wiring Diagrams: Power, signal, and control wiring
d. kVA rating
e. Primary taps
f. Insulation class and temperature rise
g. Efficiency values measured at 0, 25, 50, 75, and 100% load
h. Impedance value - X/R and %Z
i. Sound level

C. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Output Settings Report: Record output voltages and tap settings.

E. Closeout Submittals:

1. A copy of the approved submittal with the Designer's comments.
2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include spare parts data listing, source, and current prices of replacement parts and supplies.
c. Include in emergency, operation and maintenance manuals.
d. Include Manufacturer Seismic Qualification Certification, Installation Seismic Qualification Certification, Manufacturer's Ultra Quiet Transformers Sound Level Certification, where applicable, and Output Settings Report.

1.5 QUALITY ASSURANCE

A. Obtain transformers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

1.7 WARRANTY

A. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin upon acceptance of the facility completion in accordance with 2019 State Construction Manual Section 709 and NCGS 133-1.1b

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton

B. GE

C. Square D

2.2 DISTRIBUTION TRANSFORMERS

A. Fabrication:

1. NEMA ST 20, UL 1561
2. Factory assembled and tested
3. Air-cooled, for 60 Hz service
4. Two windings dry type
5. Coils:

   a. Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish
   b. Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air
   c. Materials: Copper
   d. Separate primary and secondary
   e. Internal Connections: Braised or pressure type

6. Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.
7. Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.
8. Transformer neutral visibly grounded to enclosures with flexible grounding conductor.

B. Enclosure:

1. NEMA 250.
2. Type 2, unless otherwise indicated to comply with environmental conditions at installed location.
3. Code-gauge steel panel over core and coil.
4. Ventilated (air-cooled): Louvered openings for convection cooling.
5. Cooling and terminal chamber access with both sides and rear obstructed.
6. Manufacturer's lifting eyes or brackets.
7. Finish: Manufacturer's standard gray enamel over prime coat after being degreased, cleaned and phosphatized.

C. Ratings:

1. KVA Rating: as shown on the drawings.
2. Primary Voltage: as shown on the drawings.
3. Secondary Voltage: as shown on the drawings.
4. Insulation Class and Winding Temperature Rise:

   a. Transformers 9 KVA and smaller: Class 185°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.

b. Transformers 15 KVA - 112.5 KVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature, capable of carrying 15% continuous overload without exceeding 150°C rise.
c. Transformers above 112.5 KVA: Class 220°C, with 80°C temperature rise above 40°C ambient temperature, capable of carrying 30% continuous overload without exceeding 150°C.

5. Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.

D. Primary Taps:

1. Transformers rated less than 3 KVA: none.
2. Transformers rated less than 15 KVA: one 5% above and one 5% below normal full capacity.
3. Transformers rated 15KVA and larger: two 2.5% above and two 2.5% below normal full capacity, minimum of 4 taps.

E. Energy Efficiency:

1. Transformers rated 15KVA and larger, except K-rated, quiet type and ultra quiet type:

a. Provide transformers with efficiencies in excess of DOE Efficiency Standards. Efficiency shall meet or exceed Federal Regulations CRF Title 10 Chapter II Part 431 published on January 1, 2016.

F. Sound Levels:

1. NEMA ST 20, maximum average sound levels as follows:

a. 45 dB for general-purpose transformer sizes less than 51KVA.
b. 50 dB for general-purpose transformer sizes 51-150 KVA.

2. Minimum of 3 dB less than NEMA ST 20. Maximum average sound levels as follows:

a. 42 dB for quiet type transformer sizes less than 51 KVA.
b. 47 dB for quiet type transformer sizes 51-150 KVA.

2.3 BUCK-BOOST TRANSFORMERS

A. Description: NEMA ST 1, UL 506, UL 1561, same as distribution transformers, except rated for continuous duty and with wiring terminals suitable for connection as autotransformer.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: gray enamel over prime coat.

2.4 LUGS

A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures.

B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify that space indicated for transformers' mounting meets code-required working clearances.

D. Notify Designer of discrepancies prior to submittal of product data and shop drawings.

E. Verify that ground connections are in place and requirements in Section 260526 have been met.

F. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.2 INSTALLATION

A. Refer to the drawings for additional information regarding mounting and grounding requirements.

B. Install transformers in accordance with ANSI/NECA 1.

C. Install level and plumb within 1/2 degree, and at least 6" from adjacent wall or structure to insure proper ventilation, in accordance with manufacturer’s written instruction, and in compliance with recognized industry practices.

D. Transformer mounting, seismic restraints and vibration control:

1. Mount transformers on floor on concrete housekeeping pads.

E. Install engraved plastic nameplates under provisions of Section 260553. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Indicate name, KVA rating, voltage/phase rating for primary and secondary windings, and source fed from.
2. Obtain language for nameplate from Designer.

F. Connect each transformer to rigid conduit system with maximum 36" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 260533.

G. Install transformer in per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.

3.3 CONNECTIONS

A. Ground transformers according to Section 260526.

B. Connect wiring according to Section 260519.

3.4 FIELD QUALITY CONTROL

A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 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 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5%, at secondary terminals.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262400 - SWITCHBOARDS

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 DESCRIPTION

A. This Section includes free-standing, front-access-only, dead-front type low-voltage distribution switchboards.

B. This specification is for switchboards “MDS”, “EMDS” & “S” (Existing Library Alternate).

1.3 REFERENCE STANDARDS

A. ANSI/NECA 400 - Recommended Practice for Installing and Maintaining Switchboards

B. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

C. NFPA 70 - National Electrical Code

D. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

E. NEAM AB 3 - Molded-Case Circuit Breakers and Their Applications

F. NEMA FU 1 - Low-Voltage Cartridge Fuses

G. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

H. NEMA PB 2 - Dead-Front Distribution Switchboards

I. NEMA PB 2.1 - General Instructions for Proper Handling, Installation and Maintenance of Dead-Front Distribution Switchboards Rated 600 Volts or Less

J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

K. UL 98 - Enclosed and Dead-Front Switches

L. UL 486A-486B - Wire Connectors

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

N. UL 869A - Reference Standard for Service Equipment

O. UL 891 - Dead-Front Switchboards

P. UL 1053 - Ground-Fault Sensing and Relaying Equipment

Q. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.4 SUBMITTALS

A. Cover letter with compliance table listing each specification section and indicating compliance "C", deviation for alternate "D", or exception with explanation "E". Any deviation or exception shall be accompanied with detailed explanation of how design intent is being upheld.

B. Product Data: for switchboard, components and accessories indicated:

1. Include data on features and components and complete description; submit catalog cut sheets showing voltage, size, rating and size of, switching, overcurrent protective devices, and metering/monitoring devices.
2. Futures, characteristics, factory settings and time-current curves of individual protective devices, auxiliary components and ground fault relaying.

C. Shop Drawings:

1. For switchboard specified in this Section:

a. General Arrangement:

1) Indicate front, plan, and side views of switchboards; overall dimensions and components list; shipping splits and weights.
2) Front elevation indicating location of devices and instruments.
3) Sections through switchboard showing space available for conduits.

b. Conduit entrance locations and requirements
c. Nameplate legends
d. Configuration, size and number of bus bars for each phase and current rating of buses
e. Ground bus
f. Neutral Bus
g. Short circuit ratings of switchboards and overcurrent protective devices
h. Instrument details; enclosure types and details
i. Wiring diagrams: power, signal and control wiring
j. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

D. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Complete review of this specification noting for each paragraph whether proposed equipment complies with project specifications or deviates. Justification must be given for each deviation.

G. Closeout Submittals:

1. Project Record Documents:

a. Record actual locations, configurations, and ratings of switchboard and major components on single-line diagrams and plan layouts.

2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
d. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Obtain switchboards from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

C. Certifications:

1. Qualification letter stating that the switchgear is seismically qualified per ASCE 7-05, Chapter 13, Section 13.2. Letter shall include the certification test method as described in ASCE 7-05; analysis, testing or experience data.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, fumes, water, corrosive substances, construction debris, and traffic. Provide temporary heaters in switchboards as required to prevent condensation.

B. Deliver switchboards in 48" maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids. Mark crates, boxes, and cartons clearly to identify equipment. Show crate, box, or carton identification number on shipping invoices.

C. Handle switchboards in accordance with NEMA PB 2.1 and ANSI/NECA 400. Use factory-installed lifting provisions. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 WARRANTY

A. Manufacturer shall provide standard one-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin upon acceptance of the facility completion in accordance with 2019 State Construction Manual Section 709 and NCGS 133-1.1b

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Eaton/Cutler-Hammer

2.2 RATINGS

A. Nominal system voltage: as shown on the drawings.

B. Main bus continuous amperes: as indicated on the drawings.

C. Short circuit current rating: as indicated on drawings.

D. Brace switchboard components for symmetrical fault current shown plus asymmetrical offset.

2.3 CONSTRUCTION

A. NEMA PB 2, UL 891

B. Free-standing, dead-front type; vertical sections bolted together; sides and rear covered with removable bolt-on covers; adequate ventilation within enclosure; supporting frame: steel angles or channels rigidly fastened together, with the same outside dimensions as enclosure.

C. Adequate strength and rigidity necessary to resist conditions of use to which it may be subjected and to support equipment, devices and appurtenances contained therein.

D. Provide hinged door protective cover. Front panel construction shall allow for view of the full circuit breaker label and entire trip unit. This is for investigation and adjustment of circuit breaker without need to remove cover and be exposed to bussing.

E. Incoming lug locations: bottom, as applicable per drawings.

F. Environmental Limitations:

1. Ambient temperatures: not exceeding 104°F (40°C).
2. Altitude: not exceeding 6600 ft.

G. Device Mounting and Type:

1. Front-accessible-only switchboard:

a. Main device: Fixed, compartmented Power Circuit Breaker for Switchboard “MDS”, “EMDS” and “S”.
b. Feeder devices: group mounted molded case circuit breakers.
c. Provide separate vertical sections in “EMDS” for the temporary generator/load bank circuit breaker and for the Emergency power circuit breaker as required by NEC 700.
d. Disconnecting means for SPD shall be molded case magnetic circuit breaker. Circuit breaker shall be located in the top cabinet of the main circuit breaker in an isolated, hinged cabinet. The intent is to access the circuit breaker without being exposed to the bussing.
e. The Loadbank circuit breakers shall have internal shunt trip such that if breaker is energized when ATS calls for engine start, the breaker will shunt trip.
f. The circuit breakers for the NEC 700 emergency loads shall be selectively coordinated. Provide mission critical or similar type breakers which are capable of being selectively coordinated.

H. Bus:

1. Material: copper with silver plating; copper: 98% conductivity.
2. Connections: accessible from front for maintenance:

   a. Bolted:

      1) Not fewer than 4 bolts for each 4" x 4" contact.
      2) Not fewer than 2 bolts for each 2" x 2" contact.
      3) Grade 5 bolts and conical spring-type washers.
      4) Clamp joints are not allowed.

3. Sizing: standard size, based on 65°C over 40°C
4. Main Phase Buses: 3-phase, 4 wire; uniform capacity for entire length of switchboard
5. Contact Surface: silver plated
6. Support for Buses: adequate strength for indicated short circuit current

I. Ground Bus: extend length of switchboard.

1. 1/4" by 2" minimum-size, hard-drawn copper of 98% conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.

J. Neutral Bus: 100% of the ampacity of phase buses, equipped with pressure connectors for outgoing circuit neutral cables.

K. Hinged Front Panels: allow access to circuit breaker, metering, accessory, and blank compartments.

L. Removable, Hinged Rear Doors and Compartment Covers: secured by standard bolts, for access to rear interior of switchboard.

M. Sections alignment: front and rear

N. Adequate lifting means

O. Dimensions: 90" maximum height, excluding floor sills, lifting members and pull boxes. Length and depth indicated noted on the drawing are maximum allowed.

P. Line and Load Terminations: compression type (wherever possible) accessible from front only of switchboard, labeled for 75°C copper and aluminum conductors; suitable for number, size and trip ratings. The intent is for the switchboard to be constructed such that compression type terminations can be installed. If compression type is not possible (due to circuit breaker frame type) provide mechanical connections.

Q. Enclosure: Steel, NEMA 250, Type 1:

1. Enclosure Finish for Indoor Units: factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

2.4 SHORT CIRCUIT CURRENT RATING

A. Switchboard with minimum short circuit current rating as indicated on drawings.

B. Switchboards marked with their maximum short circuit current rating at supply voltage.

C. Switchboards: fully rated. Series-rated switchboards are not acceptable.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current.

1. Thermal-Magnetic Circuit Breakers: inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes below 100A.
2. Electronic (solid-state microprocessor based) trip-unit circuit breakers: RMS sensing; interchangeable in field within frame size (field-replaceable rating plug), and the following field-adjustable settings for circuit breaker frame sizes 100 A and above:

   a. Instantaneous trip
   b. Long- and short-time pickup levels
   c. Long- and short-time time delay adjustments

3. Circuit breaker frame sizes 800A and above shall be equipped with ground fault trip functions, except as specifically noted otherwise.
4. Circuit breaker frame sizes 1200A and above shall be equipped with arc hazard reduction maintenance device to temporarily lower tripping pickup levels.
5. Circuit breaker frame sizes 1600A and above, or as noted on drawings, shall be listed for 100% of breaker's continuous ampere rating.
6. Communication Capability: circuit breaker mounted or universal mounted or integral communication module to connect to local processor with functions and features compatible with power monitoring and control system, specified in Section 262713.
7. **The emergency branch of the one line system shall be selectively coordinated as required by NEC 700. Provide circuit breakers for this branch which are capable of being selectively coordinated. Mission critical or similar type breakers.**

B. Circuit Breaker Electronic Trip Units general characteristics:

1. Circuit breakers, with solid-state microprocessor based trip units.

   a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
   b. Trip units shall be removable to allow for field upgrades.
   c. Trip units shall incorporate "True RMS Sensing."

2. Solid-state elements shall provide functions as indicated above.
3. Adjustments shall be made using non-removable, discrete steps.
4. Sealable transparent cover shall be provided over adjustments.
5. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is third-party listed as field-replaceable. Adjustable rating plug shall allow for 9 long-time pickup settings from 0.4 to 1.0 times sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match application. Long-time delay settings shall be in 9 bands from 0.5-24 seconds at 6 times Ir.
6. Short-time pickup shall allow for 9 settings from 1.5 to 10 times Ir. Short-time delay shall be 9 bands from 0.1-0.4 I2t ON and 0-0.4 I2t OFF.
7. Instantaneous settings on the trip units shall be available in nine bands from 2 to 15 times In. Instantaneous settings shall also have an OFF setting when short-time pickup is provided.
8. Trip units shall have capability to electronically adjust the settings locally and remotely to fine increments below switch settings. Fine increments for pickup adjustments are to be 1 ampere. Fine increments for delay adjustments are to be 1 second.
9. Trip unit shall indicate:

   a. Long-time fault.
   b. Short-time fault.
   c. Instantaneous fault.

d. Ground fault, where indicated on the drawings or 1000 Amps and above per NEC.
e. 24-character LCD digital display
f. Voltage and power metering (Volts, amps, kVA, kVAR, PF)
g. Power quality monitoring and alarm with waveform capture (THD)

10. Trip unit shall provide local trip indication and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
11. Trip unit shall contain means to conduct circuit breaker tests.
12. Breaker shall be equipped with externally accessible test points to be used for field testing.
13. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency.
14. Trip units shall have arc flash reduction settings (ARMS). Settings shall be activated by lockable switch on the face of the enclosure. Arc flash reduction settings shall be adjustable. Provide blue LED indicator light when ARMS mode is activated for each circuit breaker.

C. Arc Flash Reduction Maintenance Switch

1. Selector switch for Normal Mode and Maintenance Mode
2. Indicator Light

D. Ground Fault protection equipment on breakers, 1000 Amps and above or where indicated:

1. Ground-fault protection with at least 3 short-time-delay settings and 3 trip-time-delay bands; adjustable current pickup.
2. Trip shall be provided as an integral part of breaker.
3. Pick-up shall be adjustable with maximum setting of 1200 amps.
4. Time delay shall be adjustable.
5. Neutral current transformers shall be provided for 4-wire system.

E. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in 9 bands from 0.2 to 1.0 times In. Ground-fault settings for circuit breakers above 1200 A shall be in 9 bands from 500 A to 1200 A.

F. Circuit Breaker Electronic Trip Units general characteristics:

1. All overcurrent devices containing solid-state trip units shall be set by the manufacturer, and the University shall be provided with the technical information, test equipment and training necessary to test and adjust each unit.

2.6 CONTROL POWER, COMPONENTS IDENTIFICATION, AND CONTROL WIRING

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control components mounted within assembly, such as relays, pushbuttons, switches etc.: suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

D. Control Wiring: factory installed, with bundling, lacing, and protection included; flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units; insulated locking spade terminals for all control connections, except where saddle type terminals, integral to a device; current transformer secondary leads, connected to short circuit terminal blocks; terminal blocks with suitable numbering strips for group of control wires leaving switchboard, with wire markers at each end of control wiring.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Furnish removable paddle for circuit breaker, for ease of manual operation.

C. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

D. Lockout Devices: circuit breakers with integral, lockout/tagout devices.

PART 3 - EXECUTION

3.1 COORDINATION

A. Instruct manufacturer about the location of incoming lugs, i.e., bottom feed based on incoming feeder entrance location.

B. Coordinate installation of housekeeping concrete pad based on actual equipment supplied:

1. Concrete: Per requirements in Division 03 - Concrete.
2. Dimensions: as shown on the drawings. 4” tall.

C. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

D. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive switchboards for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for switchboard mounting meets code-required working clearances.

C. Notify Designer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install switchboard in accordance with NEMA PB 2.1 and ANSI/NECA 400.

B. Switchboard mounting and seismic restraints:

1. Bolt switchboards to concrete housekeeping pads, using anchor bolts in accordance with Section 260529 - Hangers and Supports for Electrical Systems. Cast anchor bolt inserts into pads.

C. Install engraved plastic nameplates under provisions of Section 260553 for switchboard, every overcurrent protective device and disconnect device. Attach nameplate to exterior of switchboard using small corrosion-resistant metal screws and rivets. Obtain nameplate language from Designer.

D. Provide arc flash labels on all electrical equipment based on engineer supplied arc flash study. Labels shall be Brady 565. Pdfs of labels will be furnished to the contractor. Contractor shall purchase and install all labels.

E. Provide printed operating instructions for switchboards.

F. Install switchboards in dedicated electrical space per NFPA 70, and as indicated on drawings.

G. Tighten electrical connectors and terminal according to equipment manufacturer’s published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

H. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

I. Apply temporary heat to maintain temperature according to manufacturer’s written instructions.

J. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

3.4 CONNECTIONS

A. Ground switchboards according to Section 260526.

B. Connect power and control wiring according to Section 260519.

3.5 FIELD QUALITY CONTROL

A. Inspect switchboards for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Test continuity of each circuit.

C. Provide acceptance testing per Section 260801.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Set field-adjustable circuit breakers trip settings, as indicated on drawings or recommended by overcurrent protective device coordination provided by Designer.

B. Field adjustments of trip setting and adjustment or replacement of equipment during start-up and commissioning at no additional cost to Owner.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

A. Provide training session by manufacturer for one workday at a job location, to train the Owner's personnel in the operation and maintenance of switchboards.

END OF SECTION 262400

SECTION 262413 - PANELBOARDS

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 DESCRIPTION

A. This Section includes circuit breaker type distribution, lighting, and appliance branch circuit panelboards as indicated on drawings and as scheduled.

1.3 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA PB 1 - Panelboards

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

F. NFPA 70 - National Electrical Code

G. UL 50 - Cabinets and Boxes

H. UL 67 - Panelboards

I. UL 486A-486B - Wire Connectors

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

K. UL 869A - Reference Standard for Service Equipment

1.4 SUBMITTALS

A. Product Data:

1. Submit catalog data showing specified features of standard products. Extraneous catalog data must be eliminated.

B. Shop Drawings:

1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
2. Product data sheets on all types of circuit breakers used in the panelboard.

C. Partial Submittals:

1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected. All panelboards shall be by same manufacturer.

D. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Closeout Submittals:

1. Project Record Documents:

a. Record actual locations of panelboards and record actual circuiting arrangements.
b. Copy of approved submittal.

2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include time-current curves, including selectable ranges for each type of overcurrent protective device.
d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70.
2. Provide products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin upon acceptance of the facility completion in accordance with 2019 State Construction Manual Section 709 and NCGS 133-1.1b.

1.8 MAINTENANCE

A. Extra Materials:

1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Cutler-Hammer/Eaton

C. Square D

2.2 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. NEMA PB 1, UL 67

B. Fabrication:

1. Factory assembled
2. Door-in-door hinged construction.
3. Cover shall have cutouts to expose the entire circuit breaker nameplate information and trip unit. This is for investigation and adjustment of circuit breaker without need to remove cover and be exposed to bussing.
4. Incoming feeder lugs: copper conductors
5. Multiple lugs to match number of conductors per phase
6. All terminations are to be rated for 75 degrees C application
7. Filler plates
8. Wiring terminals for field installed conductors: pressure wire connectors, except wire-binding screws for No. 10 AWG or smaller conductors

C. Panelboard Buses:

1. Copper
2. Ampere rating as scheduled
3. Ground bus: uninsulated, bonded to panelboard cabinet
4. Insulated neutral bus: 100% of phase bus rating

D. Molded-Case Circuit Breakers 225A and above:

1. NEMA AB 1, NEMA AB 3, UL 489; lockable handle; interrupting capacity to meet available fault current. Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for all circuit breaker trip sizes. Refer to the schedule on the drawings for additional information.
2. Circuit Breaker Electronic Trip Units general characteristics:

a. Electronic (solid-state microprocessor based) trip unit circuit breakers: digital true RMS sensing trip units; interchangeable in the field within the frame size (field-replaceable rating plug to determine the breaker trip rating), field-adjustable settings and the following trip functions for circuit breaker trip sizes 200A - 1200A:
b. Instantaneous trip
c. Long- and short-time pickup levels

d. Long- and short-time time delay adjustments with I2t response
e. Ground-fault pickup level, time delay, and I2t response
f. All overcurrent devices containing solid-state trip units shall be set by the manufacturer, and the University shall be provided with the technical information, test equipment and training necessary to test and adjust each unit.
g. The emergency branch of the one line system shall be selectively coordinated as required by NEC 700. Provide circuit breakers for this branch which are capable of being selectively coordinated above and below them on the power distribution. Mission critical or similar type breakers.

E. Branch Molded-Case Circuit Breakers below 225A:

1. NEMA AB 1, UL 489
2. Bolt-on type, labeled for 75°C copper and aluminum conductors.
3. Quick-make, quick-break, with thermal-magnetic trip.
4. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
5. Ampere rating as scheduled
6. Listed as Type SWD for lighting circuits
7. Listed as Type HACR for air conditioning equipment circuits
8. Bussing, device mounting hardware, and steel knockouts in dead front where "space" is indicated.
9. Tandem circuit breakers are not acceptable.
10. Locks on trip handles on all breakers serving transformers and where indicated on drawings.
11. Ground fault equipment protection (GFEP or GFI), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated.
12. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated.
13. The emergency branch of the one line system shall be selectively coordinated as required by NEC 700. Provide circuit breakers for this branch which are capable of being selectively coordinated above and below them on the power distribution. Mission critical or similar type breakers.

F. Cabinet

1. NEMA 250, UL 50.
2. Enclosure: NEMA 1 (indoors), NEMA 3R (outdoors), NEMA 4X (Cooling Tower location)
3. Front (trim) surface mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
4. Same height matching trim, where 2 cabinets are mounted adjacent to 1 another in finished areas.
5. Sections of panelboards have the same size, where oversize cabinets are required for 1 section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.
7. Manufacturer's standard gray enamel finish over prime coat.
8. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes in to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

2.3 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings

B. Panelboards marked with their maximum short circuit current rating at supply voltage

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

D. Spare Conduits: Stub three 1” spare conduits 72” out the top of panelboards capped for future use and identified as such, for recessed panels cap conduits 6” above accessible ceiling.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about location of additional wiring gutter space when required, i.e. top, bottom, right, left, or combination.

B. Instruct manufacturer about location of main lugs or main circuit breaker, i.e. top or bottom feed based on incoming feeder entrance location.

C. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances.

B. Notify Designer of discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting and seismic restraints:

1. Fasten panelboards firmly to walls and structural surfaces or equipment support stands, ensuring they are permanently and mechanically anchored.
2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by methods described in Section 260529.
3. Install two rows of steel slotted channel, with minimum of 4 attachment points, for each panelboard section.
4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6 ft -6" above finished floor.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with clear plastic.

G. Install engraved plastic nameplates under provisions of Section 260553. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.

1. Include panelboard name, voltage, amperage, phase, and source fed from.
2. Obtain language from Designer prior to order of labels.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Install panelboard in per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to electrical installation to be outside of dedicated electrical space.

J. Install filler plates in unused spaces.

K. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

3.4 CONNECTIONS

A. Ground panelboards according to Section 260526.

B. Connect wiring according to Section 260519.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Maintain proper phasing for multi-wire circuits.

C. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards. Refer to Section 260801.

D. Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.

E. Balancing Loads: after Final Acceptance, but not more than 2 months after Final Acceptance, conduct load-balancing measurements:

1. Perform measurements during period of normal working load as advised by Owner.
2. Tolerance: difference exceeding 10% between phase loads, within panelboard, may not acceptable. Confer with Designer and obtain direction. Contractor may be directed the reconnect or redistribute circuits and/or circuit breakers to achieve balanced condition. If so, revise circuit directory to reflect circuiting changes required to balance phase loads.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION 262413

SECTION 262513 - TRACK BUSWAYS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers track busway systems, 600 volts or less, including accessories, plug-in units and miscellaneous components.

B. This system shall be designed primarily for overhead distribution of electrical power.

C. Once installed, the track busway is to provide a simple, versatile, fast and economic means of distributing power.

D. Loads fed from a variety of plug-in units shall be easily added or removed without requiring the busway to be powered down.

E. Location of plug-in units shall be continuously adjustable across the entire length of busway, without being limited to specific locations characteristic of traditional busway.

F. Meters shall be provided in each end feed unit for circuit monitoring.

1.2 REFERENCE STANDARDS

A. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

C. UL 857

D. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Product Data:

1. Submit catalog cuts for components, accessories, and plug-in units.

B. Shop Drawings:

1. Submit for review for each type of busway and plug-in unit.
2. Indicate ratings, dimensions, layout diagram, and finishes.
3. Show fabrication and installation details.
4. Indicate location of supports and fittings.
5. Indicate required clearances, method of field assembly, and location and size of each field connection.
6. Detail connections to electrical feeds.
7. Indicate short circuit current rating.

C. Coordination Drawings: Floor plans and section (where needed), drawn to scale. Include completely dimensioned and scaled busway layouts and relationships between components and adjacent structural, mechanical, and electrical elements. Show the following:

1. Vertical and horizontal enclosed busway runs, offsets, and transitions.
2. Clearances for access above and to side of enclosed busways.
3. Vertical elevation of enclosed busways above floor or bottom of structure.
4. Support locations, type of support, and weight on each support.
5. Location of adjacent construction elements, including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Operation and Maintenance Data:

1. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
2. Include spare parts data listing, source, and current prices of replacement parts and supplies.
3. Include Manufacturer's Seismic Qualification Certification and Installation Seismic Qualification Certification.

1.4 QUALITY ASSURANCE

A. Obtain busways and plug-in units from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

1.6 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Track busways and plug-in units shall be manufactured by the same company.

B. Approved Manufacturers:

1. Starline Busway - Basis of Design
2. PDI
3. Legrand

2.2 TRACK BUSWAYS

A. Description: Track busway system: Length and configuration as shown on drawings.

B. Voltage: 120/208V

C. Frequency: 60Hz.

D. Ampacity: 60 Amp

E. Three phase, Four Conductor (plus ground) configuration

F. 100% neutral capacity. 100% ground capacity.

G. Bus Materials: Current-carrying copper conductors sized to handle 100% of its rating continuously with ambient temperature of 40 degrees C. Bus shall be electrically isolated from the busway housing.

H. Busway Housing:

1. Extruded aluminum housing with manufacturer's standard finish.
2. Housing shall be lightweight and capable of acting as a 100% rated ground.
3. Housing shall be extruded with slots to receive rod mount hangers to hang assembly from ceiling. Housing shall be open on the bottom to accept plug-in units continuously at any point along the length of the housing. This opening shall pass UL's hypothetical finger probe test.

I. Fittings and Accessories:

1. Joint kits (in-line connector)
2. End caps
3. Hanger bolts
4. One length (10ft) of closure strips per run.
5. End feed units
6. L and T connectors as shown on the drawings

2.3 PLUG-IN UNITS

A. Fused duplex receptacle Plug-in units. Provide 15 units.

B. Provide equal number of Phase A, B and C units. (5 each)

2.4 SHORT CIRCUIT CURRENT RATING

A. Busways and plug-in units shall be provided with 10,000 AIC minimum short circuit current rating.

PART 3 - EXECUTION

3.1 FIELD COORDINATION

A. Coordinate busways routing to clear work of other trades:

1. Coordinate with installation of adjacent construction elements, including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

2. Coordinate relationship between busways and adjacent structural, mechanical, and electrical elements.

B. Verify field measurements prior to fabrication.

C. Notify Designer of discrepancies prior to submittal of product data and shop drawings.

3.2 INSTALLATION

A. Install parallel to walls, floors, and ceilings.

B. Tighten bus joints using manufacturer supplied tool to assist in joining sections together.

C. Mount horizontal busway runs in upright position such that they are supported from above, and plug-in units are connected from below.

D. Hang track busway using manufacturer supplied rod mount hangers and ceiling mounted all-thread. Maximum spacing between hangers shall be 5ft on center.

E. Height of track busway system shall be as indicated on architectural details. Coordinate exact height with Designer prior to installation.

F. Provide end pieces and end caps to terminate the end of each run.

G. Provide power feed units at locations indicated on contract drawings.

H. Install engraved plastic nameplates under provisions of Section 260553 - Electrical Identification. Attach nameplates to busway using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.

I. Indicate track busway name, amperage, voltage, phase, number of wires, and source fed from (including room number where the disconnecting means is located).

J. Do not install track busway system until building is weather tight and under no less than temporary environmental controls.

3.3 FIELD QUALITY CONTROL

A. Inspect busways for physical damage, proper alignment, supports, and seismic restraints.

B. Inspect busway components, wiring, connections, and grounding.

C. Meggar test busways immediately prior to energizing, interpret test results in writing and submit to Designer.

3.4 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

END OF SECTION 262513

SECTION 262713 - ELECTRICAL SYSTEM METERING

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 DESCRIPTION

A. Provide electrical metering system per the UNCW Utility Meter Setup Guidelines dated 02/16/2017. This includes all responsibilities by the installing contractor as detailed in that document.

B. It is the design intent to consolidate all separate meters into an ethernet gateway and map that data to the BAS system (using MODBUS protocol). The Ethernet gateway shall also directly connect to the LAN to communicate with the existing campus SCADA system via TCP/IP for remote monitoring. Metering system shall be web-enabled for remote view all metering/monitoring points over Ethernet. Provide all work for this connectivity to meet the overall electrical system metering design intent.

C. Provide work to map data points as specified to the local BAS system and remote SCADA system.

D. Refer to the drawings for additional information on metering system architecture. Each service shall have a Power Quality Meter (PQM) and all circuit breakers shall have trip unit with integral metering with local LCD readout.

E. Provide meters on all electrical equipment 1000 amps or more and as indication on the drawings or in other sections of the specifications.

F. Note that additional information for the meters and electronic trip units for circuit breakers is indicated in associated specification 262400.

1.3 REFERENCE STANDARDS

A. ANSI C12.1 - Code for Electrical Metering.

B. UL 414 - Meter Sockets.

C. UL 916 - Energy Management Equipment.

1.4 SUBMITTALS

A. Cover letter with compliance table listing each specification section and indicating compliance “C”, deviation for alternate “D”, or exception with explanation “E”. Any deviation or exception shall be accompanied with detailed explanation of how design intent is being upheld.

B. Submit shop drawing data sheets for each meter and other equipment provided under this section.

C. Submit shop drawing schematics for entire metering system architecture to clearly indicate conformance with the specification. This includes:

D. Every meter in each switchgear including model number.

E. Wiring connections between all devices including wiring type.

F. Associated components including Ethernet gateway, protocol translator to include physical dimensions and heat rejection.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Power Quality Meters:

1. Service Switchgear: Electro Industries – "Nexus 1262" or equal by Cutler-Hammer, SquareD.
2. Distribution Switchboards and Panelboards: Electro Industries – "Shark 200" or equal by Cutler-Hammer, Square D.

B. Trip Unit Meters:

1. ABB - EMAX PR123
2. Cutler Hammer – 1150+
3. Squared D – Micrologic 6.0H

2.2 OWNER MONITORING METERING

A. All circuit breaker meters shall have the following features:

1. Meters shall be:

a. Microprocessor based.
b. Digital Readout.
c. 3-phase for connection to 4-wire systems.

2. All meter shall display direct readout metered or calculated values of:

a. Volts (V).
b. AMPS (A).
c. Apparent Power (VA).
d. Real Power (kW).
e. Power Factor (PF).
f. Reactive Power (VAR).
g. Amps Demand (Ad).

h. Real Power Demand (kWd).
i. Frequency (Hz).
j. Real Power Usage (kWHr).
k. Total Harmonic Distortion, Amps (THD).
l. Total Harmonic Distortion, Volts (THD).

B. PQM service meter (on each service) shall incorporate the following additional features:

1. Waveform Capture
2. Trending and forecasting
3. Alarm Summary
4. Voltage Flicker and Sag/Swell metering
5. Provided with 10-pole test switch (nickel plated with cover), with 4 handles tied to voltage and 6 handles tied to current. Test switches shall comply with ANSI C12.9.
6. Provide data outlet adjacent to the meter in the switchgear for meter connection to the building network.

C. PQM submeter (on panelboards as shown on the drawings) shall incorporate the following additional features:

1. INP1000S option (100 base T Ethernet card).
2. Separate hinged enclosure for the meter, current transformers, test switches, circuit breakers for voltage connection, and power supply. Provide fused disconnecting means for input voltage reference (0.1amp fuse) and power supply (3amp fuse) per UNCW guidelines.
3. Provide data outlet adjacent to the meter in the enclosure for meter connection to the building network.

D. Current Transformers

1. Current Transformers shall be:

a. 5 Amp secondary.
b. Primary ratio as shown on plans.
c. Bar or window type.

E. Potential Transformers

1. Potential Transformers:

a. 600V and below:

1) External PT's not required.
2) Provide fused potential connection.

F. Data Communications

1. Meters shall be daisy-chain connected inside each Switchgear and routed to Ethernet gateway.
2. Metering system data shall be mapped to BAS system (using MODBUS protocol). Provide all work for that interface to include wiring and conduit to BAS cabinet.
3. Metering system shall be connected to campus central SCADA system via TCP/IP. Provide all work for that interface to the campus network as well as programming modifications to the existing SCADA system.
4. Ethernet ports for connection to local telecom patch panel.
5. Provide means to transmit data to central control systems. Refer to the drawings for all switchgear monitoring points.

a. Two RJ45, two RS485 and one RS232 communications ports.
b. Keypad and display for local reading of measured values.
c. Access using MODBUS protocol.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Meters to be mounted on the outside of the enclosure for associated Switchgear, Switchboard, or Panelboard.

3.2 WIRING INSTALLATION

A. Install wiring in conduit outside of the associated equipment.

3.3 ACCEPTANCE TESTING

A. Testing by equipment manufacturer and Contractor.

B. Contractor shall turn over all PQM meter(s) to the UNCW Construction Project Manager a minimum of four (4) weeks prior to the provision of permanent power. UNCW will return the meters within a two (2) week period once IP addressing has been completed. Permanent power will not be turned on to any facility until the main building meter is installed and is operational.

C. Contractor shall be responsible for programming the PQM meters with UNCW's standard display template, and that the contractor will also be responsible for programming all the needed electrical parameters into PQM meters. The contractor will also install and complete the installation, leaving the meters ready for operation. Note: The actual programming of the meters could be performed by the manufacturer.

D. Coordinate with Controls Contractor shall provide the necessary software, programming, graphics, points, etc. to input the data from the PQMs to the campus Tridium/Vykon Energy Management System for graphing, charting, and trending the data. The data to be monitored and displayed is energy usage (kW-hr), instantaneous demand (kW), and month-to-date peak demand (kW). All energy management metering issues must be resolved prior to final inspection.

E. PQMs shall be verified by the NETA testing agent per Section 260801.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

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 DESCRIPTION OF SYSTEM

A. Provide devices such as switches, receptacles, plates, etc., as shown on drawings and specified.

B. Openings shall be covered with either devices and matching plates, solid blank plates or blank plates with bushed opening.

C. Devices shall be installed plumb, tight to wall surfaces and free of scratches or blemishes.

D. Devices of same type shall be from same manufacturer, unless otherwise noted

1.3 REFERENCE STANDARDS

A. Federal Spec. W-C-596F Federal Specifications for Electrical Power Connections

B. Federal Spec. W-S-896-E Federal Specifications for Endurance Testing

C. ANSI NEMA WD-6 Wiring Devices - Dimensional Requirements

D. NEMA WD-1 General Color Requirements for Wiring Devices

E. UL 20 - General Use Snap Switches

F. UL 94V2 - Flammability Testing

G. UL 498 - Attachment Plugs and Receptacles

H. UL 505 - Motor Starter Switches

I. UL 943 - GFCI's 2003

J. UL 1449 - Surge Suppression Devices

1.4 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. Weatherproof cover plate samples if requested by Designer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Cooper, Hubbell-Bryant, Leviton, Pass & Seymour.

2.2 FABRICATION AND MANUFACTURER

A. Switches:

1. Toggle:

a. 20 Ampere, 120-277 Volt AC, quiet type.
b. White colored.
c. Heavy duty toggle
d. Industrial-Institutional, heavy-duty specification grade
e. Color-coded face to indicate ampere rating
f. Heavy gage steel mounting strap
g. Green Ground terminal
h. Silver alloy contacts
i. Motor rated for 1 HP

B. Receptacles

1. Duplex

a. Industrial-Institutional, heavy-duty specification grade
b. 2 pole, 3 wire grounding
c. Separate ground screw
d. 20 Ampere, 125 Volt, NEMA 5-20R configuration (unless noted otherwise on the drawings)
e. WHITE colored bodies for normal circuits, RED colored bodies for Generator circuits.
f. Solid 1-piece brass mounting strap with integral ground contacts
g. Impact resistant thermoplastic face

2. USB Charger Receptacle

a. Industrial-Institutional, heavy-duty specification grade
b. 2 pole, 3 wire grounding
c. Separate ground screw
d. Two type A port configuration
e. High power 5 Amp, 5 Volt USB outlet
f. Tamper-resistant duplex receptacle
g. USB ports rated 10,000 cycles

3. Ground Fault Circuit Interrupter (GFCI):

a. Meet requirements of duplex in addition to:

1) 20 Ampere, 125 Volt
2) NEMA 5-20R configuration
3) Trip level 4 to 6 mAmpere
4) Trip time .025 seconds nominal
5) Feed-through design to protect downstream devices on circuit.
6) Reverse line-load function to prevent GFCI from functioning if wired incorrectly

4. Locking type
   a. Meet requirements of duplex in addition to:
      1) Back or side wired
      2) Accept up to #8 AWG
      3) Contact spring shall be 1 piece, no rivet construction
      4) Body of device shall be high temperature glass reinforced nylon, suitable for 140°C/284°F continuous use.
      5) Meet UL 175 C.T.I. test
      6) Configuration stamped on the face
      7) 20 and 30 Amp receptacle shall have 1.55" boss diameter
5. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

C. Wall Plates
1. 302 stainless steel, non-magnetic in finished areas.
2. Weatherproof covers:
   a. Interior Receptacles: Cast aluminum with gasket and spring hinged flip open cover that is not classified as “not in use” type, suitable for wet locations. This is typical for all interior receptacles in unfinished spaces.
   b. Exterior Receptacles: Weatherproof Cover Plates: Exterior mounted receptacle plates, and those noted to be weatherproof in-use type and shall include weatherproof PVC cover plates, standard size, single or ganged as indicated on the drawings, and shall be “approved” third party as rain-tight while in use and not in use. The unit shall include a weatherproof cover/base assembly, gasket, and stainless-steel mounting screws. The cover shall meet or exceed UL requirements for wet locations while in use. The weatherproof receptacle cover shall be designed to meet requirements of NEC Article 406.9(B)(1) and shall be NEMA 3R rated. The weatherproof cover shall be constructed entirely of UV stabilized high impact polycarbonate material.
3. Exterior Switches: Cast aluminum with gasket and spring hinged flip open cover that is not classified as “not in use” type, suitable for wet locations.

D. Cord Reels
1. Provide cord reels as shown in the drawings. Provide an outlet in the ceiling tile for interconnection.
2. Provide independent support from structure and attach to support with screws or bolts as needed.
3. Uline item# H-6412 – 65’, spring retraction, 125VAC, quad outlet, NEMA 5-15R
4. Acceptable Manufacturers – RTA, Hubbell, Lumapro
5. Verify color with architect.

2.3 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Comply with NEMA FB 11 and UL 1203

B. Manufacturers:
1. Cooper Crouse-Hinds
2. EGS/Appleton Electric
3. Killark; a division of Hubbell, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices at heights scheduled, and as indicated on drawings.

B. Install duplex wall receptacles vertically with ground contacts up except where shown otherwise or where space problem occurs.

C. Indicated dimension are to centerline of device.

D. Install lighting switches vertically on latch side of door within 6" of frame edge.

E. Install devices back box 2" above countertop, backsplash or fixed cabinet to bottom of back box.

1. Install devices at same height above 1 countertop, backsplash or fixed cabinet.

F. Verify locations prior to rough-in.

G. Install devices plumb, level with finished surfaces and free from blemishes.

H. Install special purpose receptacles and switches and fixed equipment connections according to shop drawings and rough-in drawings to be furnished by trade(s) providing such equipment.

I. Verify locations prior to rough-in.

J. Identify all receptacles with pre-printed "Brady" clear vinyl polyester tape with black lettering on front of plate.

1. Label shall indicate panelboard name and circuit number (of source serving device).
2. Label shall indicate receptacle voltage, phase, and amperage for receptacles other than 20A, 120 Volt.

K. Identify switches with pre-printed "Brady" clear vinyl polyester tape with black lettering on front of plate.

1. Label shall indicate panelboard name and circuit number (of source serving device).

L. All receptacles in wet location and those shown exposed to exterior elements are to be provided with weather proof while in use covers and weather resistant wiring devices.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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 DESCRIPTION

A. This Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.3 REFERENCE STANDARDS

A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

D. NFPA 70 - National Electrical Code

E. UL 98 - Enclosed and Dead Front Switches

F. UL 486A - 468B - Wire Connectors

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

H. UL 869A - Reference Standard for Service Equipment

1.4 SUBMITTALS

A. Product Data:

1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, terminal lugs and accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.

B. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Closeout Submittals:

1. Project Record Documents:

a. Record actual locations of disconnect switches and associated ratings.
b. Record actual locations and type/rating of enclosed circuit breakers including trip unit.

2. Operation and Maintenance Data:

   a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.5 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer shall provide standard 1-year written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of final acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Cutler-Hammer

C. Square D

2.2 DISCONNECT SWITCHES

A. NEMA KS 1, UL 98

B. Load interrupter enclosed knife switch, heavy-duty type

C. Non-fusible type as indicated.

D. Switch Interiors:

1. Switch blades that are visible in "OFF" position when switch door is open
2. Plated current carrying parts

E. Switch Mechanism:

1. Quick-make, quick-break, with visible blades and externally operable handle
2. Lockable only in "OFF" position and accept three industrial type, heavy-duty padlocks
3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open
4. Defeater mechanism to bypass interlock
5. Operating handle integral part of enclosure
6. Handle to physically indicate "ON" and "OFF" position

F. Ratings:

1. Ampacity as indicated on drawings
2. Horsepower rated

2.3 ENCLOSED CIRCUIT BREAKERS

A. NEMA AB 1, UL 489

B. Enclosed molded-case circuit breakers:

1. Tripped indication clearly shown on breaker handle taking position between "ON" and "OFF".
2. Thermal-magnetic trip unless noted otherwise on the drawings
3. Where indicated on the drawings: electronic (solid-state microprocessor-based) trip units interchangeable in field within frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
4. Locks on trip handles where indicated.

C. Breaker Mechanism:

1. Quick-make, quick-break

D. Ratings:

1. Ampacity as indicated on drawings
2. Listed as Type HACR for air conditioning equipment circuits
3. Listed as Type SWD for lighting circuits

2.4 LUGS

A. Front removable lugs

B. Labeled for 75°C copper and aluminum conductors

C. Multiple lugs to match number of conductors per phase

D. Termination of field installed conductors: pressure wire connectors, except wire-binding screws for No. 10 AWG or smaller conductors

2.5 ACCESSORIES:

A. Equipment ground kit

B. Provide two auxiliary contacts for all disconnects serving motors. Disconnects serving motors controlled via VFD shall be provided as follows:

1. Interlock kit consisting of 2 NO and 2 NC contacts. Interlock kit shall attach to pivot arm of switch mechanism.
2. Contact shall break control circuits before main switch blades break and close control circuit after main switch blades close.
3. Electrician shall provide all work to include conduit, wiring and other remainder of work for that interlock system. Controls contractor shall make final terminations in VFD and complete programming.

2.6 ENCLOSURES

A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.

B. NEMA Types:

1. Type 1 (indoors unless noted otherwise on the drawings)
2. Type 3R (outdoor locations except on roof)
3. Type 4X - stainless steel (on roof).

C. Code-gauge galvanized steel

D. Manufacturer's standard gray enamel finish over prime coat

E. Surface-mounted.

F. Except for NEMA 4X construction, front panel construction shall allow for view of the full circuit breaker label and entire trip unit. This is for investigation and adjustment of circuit breaker without need to remove cover and be exposed to bussing.

2.7 SHORT CIRCUIT CURRENT RATING

A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.

C. Notify Designer of discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.

B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.

C. Disconnect switches and enclosed circuit breakers mounting and seismic restraints:

1. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
2. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by methods described in Section 260529.
3. Install 2 rows of steel slotted channel, with minimum of 4 attachment points, for each disconnect switch and enclosed circuit breaker.
4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

D. Do not support disconnect switches and/or enclosed circuit breakers only by raceway.

E. Install top disconnect switch and/or enclosed circuit breaker handle a maximum of 6 ft-6” above finished floor.

F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A - 486B.

G. Install engraved plastic nameplates under provisions of Section 260553. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.

H. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526.

B. Connect wiring according to Section 260519.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Circuit Breakers: set field-adjustable trip settings or change the trip settings, during start-up and commissioning at no additional cost to the owner.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262816

SECTION 262913 - MOTOR CONTROLLERS

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.

B. Refer to 260000 for additional information on division of responsibilities for motors and motor controllers.

1.2 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the GENERAL CONDITIONS, SUPPLEMENTAL GENERAL CONDITIONS, and sections under Division 1 - GENERAL REQUIREMENTS.

1.3 DESIGN CRITERIA

A. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter, VFD or disconnect switch. Under Division 26 line side termination shall be provided. Wiring from the load side of each termination point to the mechanical equipment including final connections shall be provided under Division 23. Refer to electrical drawing details for additional information.

B. Provide power circuit disconnect devices shown on the drawings unless shown or specified to be furnished by others (mechanical contractor, manufacturer, etc.).

C. Provide connecting lugs for equipment specified in this Section as well as for equipment furnished by other contractors for this project.

D. VFD’s shall be furnished by mechanical contractor.

E. Motors 1/2 HP and smaller shall be served with 120 volts, single phase, unless noted otherwise on the drawings.

F. Motors larger than 1/2 HP shall be served with NEMA rated 480-volt, 3 phase, unless noted otherwise on the drawings.

G. Motors larger than 15HP shall be reduced voltage, solid-state starting type.

H. Factory internal wiring shall be NEMA Class 1, Type B.

1.4 SUBMITTALS:

A. Shop drawings for equipment provided under this Section. Shop drawings shall be from manufacturer, specifically tailored to this project that indicate all optional accessories required. Manufacturer general brochures and catalog cut sheets are not acceptable. The manufacturer shop drawings shall acknowledge that existing equipment is being modified and/or added to (for the buss extension) and appropriately show that work.

1.5 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Cutler Hammer

C. Square D

2.2 EMERGENCY STOP PUSHBUTTON

A. Provide an emergency stop (E-stop) pushbutton with plastic protective lockable cover at all motors controlled by VFD as shown on the drawings to automatically stop/start the motor. E-stop shall be hardwired into the motor start circuit for a normally closed signal at the VFD. This pushbutton is used in lieu of a traditional disconnect switch on these motors to improve safety.

B. Pushbutton shall be pull-to-stop / push-to-start operation capable of being locked in the stop position with language on an engraved label on the pushbutton. Pushbutton shall be RED in color.

C. Provide clear, plastic protective lockable flipcover/shield to avoid accidental operation. Cover shall be weatherproof in exterior locations.

D. All work associated for a complete and operational system for the e-stop pushbuttons (to include wiring) shall be by the Electrical Installer. Final termination in the VFD shall be by Div 23.

2.3 MOTOR CONTROL EQUIPMENT

A. Motor Disconnect Devices:

1. Refer to Section 262816 – Enclosed Disconnect Switches and Circuit Breakers for disconnect switches not in combination with motor starters.
2. Provide disconnect devices as required by codes and as specified.
3. Provide disconnect device with overcurrent protection electrically connected in line side of each starter.
4. Disconnect device shall be capable of being locked in open position.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Circuit breakers installed in motor controllers shall have the following characteristics:

1. NEMA AB 1, UL 489.

2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors.
3. Quick-make, quick-break, with electronic (solid-state microprocessor-based) trip.
4. Equipped with individually insulated, braced, and protected connectors.
5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
6. Ampere rating as scheduled.
7. Tripped indication clearly shown by breaker handle taking position between “ON” and “OFF”.
8. Thermal-magnetic trip.
9. Interrupt rating (kAIC) as shown on the drawings to match upstream overcurrent protective device.

2.5 FULL-VOLTAGE NON-REVERSING MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS2, AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower, three-phase, as scheduled:

1. Size 1 minimum; unless shown otherwise on the drawings.
2. Control Voltage: 120 volts, 60 hertz. (derived locally)
3. Overload Relays: NEMA ICS 2, solid-state, one overload relay per phase.

a. Solid-state type:

1) Class 10, 20, selectable inverse-time tripping characteristics
2) Non-volatile operating memory
3) 3:1 current adjustment range
4) Phase loss/phase unbalance protection
5) Ambient temperature insensitive
6) Self-powered
7) Manual reset. Automatic recent not acceptable.
8) Manual trip
9) Visible trip indication
10) 1 normally open and 1 normally closed isolated auxiliary contract
11) Class II ground fault protection.
12) Jam/stall protection.

b. Features:

1) Auxiliary Contacts: NEMA ICS 2, 2 each normally open and normally closed contacts in addition to seal-in contact
2) Pushbuttons: covered
3) Pilot Lights: NEMA ICS 5 push-to-test LED type
4) Hand-Off-Auto (H-O-A) Selector Switches: rotary type
5) Control Power Transformers: 120-volt secondary, adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity in each motor controller, but not less than 100VA. Fused primary and secondary, and unfused leg of secondary bonded to enclosure.
6) Terminals: NEMA ICS 4
7) Other accessories detailed or required by drawings.
8) There shall be no time delay associated with the starters.

2.6 SOLID-STATE REDUCED-VOLTAGE CONTROLLERS

A. Description: NEMA ICS 2, suitable for use with standard NEMA MG 1, Design B, polyphase, medium induction motors

1. Power section consisting of 3 power modules, each with 2 thyristors connected in inverse parallel, and mounted on common, insulated base. Thyristors shall be connected in "6 pulse" configuration.
2. Electrical

a. Input voltage: 480 Volts ± 10%

b. Input frequency: 60 Hz
c. Output voltage: 40 to 100% of input
d. Start (Voltage Ramp) time: 0.5 - 60 seconds
e. Current (torque) control 100% - 500%

3. Adjustable acceleration rate control (uses voltage or current ramp), and adjustable starting torque control (up to 500 percent current limitation for 20 seconds)
4. Surge suppressor in solid-state power circuits to provide 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
5. LED indicators to show motor and control status, including the following conditions:

a. Control power available
b. Controller on
c. Overload trip
d. Loss of phase
e. Shorted silicon-controlled rectifier

6. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
7. Motor running contractor operates automatically when full voltage is applied to motor.

2.7 COMBINATION CONTROLLERS

A. Factory-assembled motor controllers with externally operable disconnect, molded-case circuit breaker type, in common enclosure; means for locking disconnect handle and means for defeating cover interlock.

2.8 MOTOR CONTROLLER ACCESSORIES

A. Factory installed devices in controller enclosure, unless otherwise indicated, as follows:

1. "On-Off" and "Start-Stop" pushbutton stations, pilot lights selector switches: NEMA ICS 2, heavy duty type.
2. 120-volt control circuits and pilot light, unless noted otherwise (power derived locally)
3. Red pilot light to indicate motor operation
4. Green pilot light to indicate motor stopped
5. Minimum wire size for control circuits: #14 AWG
6. Stop and Lockout Pushbutton Station: momentary-break pushbutton station with factory-applied hasp arranged so padlock can be used to lock pushbutton in depressed position with control circuit open, where indicated.
7. Control Relays: auxiliary and adjustable time-delay relays, where indicated:

a. Phase-Failure and Undervoltage Relays: solid-state sensing circuit with isolated output contacts for hardwired connection, with adjustable undervoltage setting.

2.9 FEEDER OVERCURRENT PROTECTION

A. Molded-case circuit breakers:

1. Thermal-magnetic trip or electronic (solid-state microprocessor-based) trip per Section 2.4.

2.10 LUGS

A. Labeled for 75°C copper conductors.

B. Multiple lugs to match number of conductors per phase.

C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for No. 10 AWG or smaller conductors.

D. For equipment specified in this section and for equipment furnished under other Divisions of this Specification and/or by others.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor controller in accordance with NEMA ICS 2.3 and ANSI/NECA 1.

B. Motor controller enclosure mounting and seismic restraints:

1. Mount in accordance with Section 260529.

C. Install engraved plastic nameplates under provisions of Section 260553. Attach nameplate to exterior of cabinet using small corrosion-resistant metal screws and rivets. Do not use contact adhesive.

D. Tighten electrical connectors and terminal according to equipment manufacturer's published torque tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A-486B.

E. Connect each motor terminal box to rigid conduit system with maximum 36" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 260533.

F. Check for proper rotation and phase relationship of each motor.

G. Control Wiring Installation.

1. Install wiring between motor control devices according to Section 260519.
2. Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.
3. Bundle, train, and support wiring in enclosures.
4. Connect hand-off-automatic switch and other automatic-control devices where applicable.

a. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
b. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

H. Provide Myers hubs (or equal) on all conduit penetrations into the top of boxes to provide a watertight connection to avoid water, dirt, and debris entering the cabinet.

3.2 APPLICATION

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor and configuration of pilot device and control circuit affecting controller functions.

3.3 CONNECTIONS

A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.

B. Ground motor control centers according to Section 260526.

C. Connect power and control wiring according to Section 260519.

D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.4 FIELD QUALITY CONTROL

A. Inspect motor controllers for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test continuity of each circuit.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change trip settings, as indicated on drawings.

B. Adjust motor circuit protectors and overload relays, as required.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION 262913

SECTION 263213 - ENGINE GENERATORS

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 DESCRIPTION OF SYSTEM

A. This section describes one complete package generator set, with unit-mounted radiator cooling system, microprocessor-based control and monitoring panel, battery and charger, communications module, remote annunciator, sub-base fuel tank, main circuit breaker and sound-attenuated, weather-proof enclosure. Provide factory enclosure with options to meet the intent of the specifications.

B. The generator shall be rated for emergency use per NFPA 110. The generator shall be located in a separate outdoor, enclosure with a minimum sub-base double-wall fuel tank sized to hold fuel for minimum 56-hour runtime at 100% load.

C. The generator manufacturer shall be responsible for providing all equipment within the generator enclosure for an integrated central generator system as one package. This includes all wiring that is internal to the enclosure. The generator manufacturer shall furnish all controls wiring to the remote annunciators, BAS system, and automatic transfer switches which will be installed by the Contractor. Power cabling to/from the generator enclosures shall be provided by the Contractor.

D. Package generator set shall be standby rated and shall meet US EPA emissions rating for "emergency standby use" at specified horsepower, manufactured the same year the Contractor was authorized the purchase the generators.

E. The generator system shall be provided by the factory authorized distributor of the engine. The supplier shall have a parts and service facility located within 250 miles of the jobsite with factory-trained technicians in full time employ and a stock of spare parts. The engine shall be the product of an established United States of America engine manufacturer and is a model that has been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability.

F. The equipment manufacturer shall coordinate directly with the Prime Contractor and provide dimensioned shop drawings for the generator enclosure and conduit openings/windows through the pad.

1.3 REFERENCE STANDARDS

A. NEMA MG-1 - Motors and Generators

B. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

C. NFPA 37 - Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines.

D. NFPA 110 - Standard for Emergency and Standby Power Systems.

E. 40 CFR 60, Subpart IIII (EPA)

F. IEC8528 Part 4 – Control Systems for Generator Sets.

1.4 SUBMITTALS

A. Compliance Package: Submit document package confirming specifications and design intent have been met. Compliance package shall include, but shall not be limited to, the following:

1. Cover letter with compliance table listing each specification section and indicating compliance "C", deviation for alternate "D", or exception with explanation "E". Any deviation or exception shall be accompanied with detailed explanation of how design intent is being upheld.
2. Complete bill of materials.
3. Engineering drawings for each component on the bill of materials. Drawings shall indicate physical dimensions of equipment and enclosures.
4. Single line diagram including actual configurations of components
5. Product catalog sheets or equipment brochures.
6. Product guide specifications.
7. Emissions certificate from the manufacturer documenting the air emissions performance.

B. Shop Drawings

1. The following is furnished by the manufacturer:
2. Provide for engineering review and approval prior to production release. Include the following for engine-generator:

   a. Outline drawings of equipment showing weights
   b. Overall dimensions including bolting template and earthquake restraints
   c. Right hand, left hand, end, and top views of proposed assembly
   d. Battery, battery rack, battery charger, and wiring diagrams
   e. Vibration isolation bases, mounts, and hangers
   f. Exhaust silencer and flexible fittings
   g. Stub ups for fuel
   h. Power and control wiring entrance locations
   i. Lug sizes and locations
   j. Engine-generator control panel drawings showing all devices to be provided, with each device referenced to material list with complete description for device.
   k. Sound performance data
   l. Muffler characteristics
   m. Factory certified prototype test report indicating fuel efficiency and emission levels.

3. Information on engine characteristics:

   a. Make, type, and number of cylinders
   b. Brake horsepower (bhp) available
   c. Jacket water heat rejection
   d. Cooling pump characteristics
   e. Exhaust flow rate and temperature at 25, 50, 75, and 100% rated load
   f. Ventilation requirements
   g. Combustion air requirements
   h. Fuel consumption rates at 25, 50, 75, and 100% rated load
   i. Liquid refill capacities
   j. Exhaust backpressure limitation
   k. Type and manufacturer of governor

4. Information on generator characteristics:

   a. Make and type
   b. Type of construction and overspeed capabilities
   c. Temperature rise

d. Regulation characteristics
e. Ventilation requirements
f. Type of winding insulation
g. KW power factor
h. Type of exciter and voltage regulator

5. Outdoor enclosure and Sub-base Fuel tank:

a. Overall dimensions of enclosure
b. Dimensions of all internal components
c. Clearance requirements interior/exterior to the enclosure
d. Recommending means for maintaining/removing various components inside switchgear
e. Capacities
f. Total weight of enclosure with components installed and all liquids including fuel
g. Sound attenuation levels (total including engine and exhaust)
h. Location(s) of fueling ports
i. Location(s) of conduit stub-us for power to/from enclosure, and controls cabling.
j. Complete shop drawings indicating construction, dimensions, support structures, etc. of enclosure
k. Product Data Sheets for all components of generator system and auxiliary components inside enclosure
l. Auxiliary power requirements for generator enclosure system.
m. Galvanized steel stairs with hand-rails for steps to each door of the enclosure

6. Interconnection detail drawing showing control and power connections in entire generator system. Control connections between components are to be labeled with identical nomenclature. Coordinate with generator manufacturer.
7. Accessories including fuel lines, flexible exhaust couplings, exhaust flange, and other exhaust system components.
8. Complete test specification per NFPA 110, detailing testing procedure to be used to verify performance of equipment provided.
9. Recommended spare parts lists.

C. Certified Factory Test Reports:

1. Certified Factory Test Report shall be per the requirements of NFPA 110.
2. Submit standard manufacturer certified factory tests report on engine-generator delivery. All alarms, sensors, and meters must be tested and certified. Factory test shall include:
3. Full load at rated PF
4. KVA, KW, Amperage, voltage, frequency.
5. Phase voltage balance
6. Stator and exciter field resistance
7. Insulation test
8. Dielectric test
9. Safety shutdown controls
10. Submit, upon completion of installation and testing of engine-generator sets, certified test reports from load tests for each engine-generator.
11. Submit generator paralleling operation test report.

1.5 QUALITY ASSURANCE

A. Obtain generators (and associated components and accessories) from one source and by single manufacturer.

B. Manufacturer's authorized representative for start-up, maintenance, and service contracts shall be located within 250 miles of the site.

C. Manufacturer shall be responsible for all the work for the engineering and design of the enclosure, structural supports, vibration isolators, any associated stairs and platform, emissions compliance, noise attenuation, and wind loading.

D. The testing agency shall be a nationally recognized testing laboratory. The on-site testing technician shall be certified by IETA.

E. Regulatory Requirements:

1. Comply with NFPA 30, 37, 70, 99 for components and installation.
2. Comply with UL 142, 2200 for components and installation.
3. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled in accordance with manufacturer's written instructions. One copy of these instructions shall be included with the equipment at the time of shipment. Maintain factory bracing, packaging, and wrapping.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 - Closeout Procedures and herein below.

B. The Operation and Maintenance (O&M) manuals shall be submitted to the Designer for review prior to acceptance of the unit.

C. Installation, maintenance, and operating instruction manuals shall include, but not be limited to, the following:

1. Complete finalized submittal with all iterations of review comments.
2. Complete factory test report.
3. Complete site acceptance report.
4. Letter with all contact information for manufacturer, local authorized service representative, testing agency and on-site technician.
5. 100% accurate system "as-installed" drawings, interconnect diagrams, schematic diagrams, wiring diagrams, individual sub-system component manuals, operation procedures, system description with theory of operation, maintenance schedules and procedures, original programmed settings and parameters, and all other information necessary for the Owner to maintain, operate, test, and troubleshoot the system.
6. The O&M manual shall contain step-by-step instructions for startup and shutdown. The first page shall contain the name, address, and phone number of the local representative to be called for service or parts. This shall be followed by complete parts lists by actual ordering catalog numbers. The O&M manual also shall contain four copies each of test record forms and service record forms for Owner use. These forms shall show the proper interval for testing, servicing, and replacing of all components, lubrication, filters, antifreeze, etc., including recommended specifications and fluid levels for all lubricants.
7. Recommended spare parts list (with pricing) for two years of operation.

D. O&M manuals shall not solely rely on sub-component manuals. A thorough consolidation of operating and maintenance information shall be available in a system overview guide. All major components of the system shall be included in this overview.

E. Provide three final reviewed manuals to the Owner prior to conducting the training of Owner personnel.

F. A single copy of the service record forms, recommended operation and service practices for the unit shall be sealed in plastic and wall mounted in the weather protective enclosure.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:

1. Caterpillar – Preferred Brand Alternate
2. Engine Generator Set - Caterpillar, Cummins, MTU
3. Exhaust Silencer - Maxim, Nelson, or approved equal
4. Isolation Equipment - Consolidated Kinetics, Korfund Co., Mason Industries
5. Battery charger - La Marche, Sens, Enersys, or approved equal

2.2 RATINGS AND PERFORMANCE

A. Engine Generator Set

1. Generator Output: as shown on drawings at 0.8 power factor.
2. Voltage: 480V
3. Frequency: 60 Hz
4. Excitation: Permanent Magnet

B. System Performance:

1. On closing of starting contact, engine-generator shall be capable of accepting full rated load and stabilizing at rated voltage and frequency within 10 seconds.
2. Voltage regulation shall be plus or minus 0.5% for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 1.0%.
3. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%. For any addition of load up to 90% of rated load, the frequency shall recover to the steady state frequency within 5 seconds.
4. Diesel engine-generator set shall accept single step load of 100% nameplate kW and power factor, less applicable derating factors, with engine-generator set at operating temperature.
5. For any addition of load up to and including 90% of rated, the voltage shall recover to and remain within the steady band in not more than 1.5 seconds. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes, shall not exceed 20%.
6. Alternator shall produce clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no third-order harmonics or their multiples. Telephone influence factor shall be less than 40. Telephone harmonic factor shall be less than 3.
7. Engine-generator set shall be certified by engine manufacturer to be suitable for use at installed location and shall meet applicable exhaust emission requirements at time of commissioning.

C. Transient Performance

1. Engine

a. Meets ISO 8528-5 transient response
b. Start and load in 10 seconds per NFPA 110
c. Accept 100% block load per NFPA 110

2. Frequency regulation +/- 5% no load to full load. +/- .5% steady state speed droop shall be adjustable from 0 to 10%, from no load to full load, and share within 5% when paralleled with similarly equipped engines.
3. Alternator:
   a. 20% Voltage dip
   b. Temp rise: 105C over 40C ambient at Standby rating
   c. AC waveform output contains < 5% total harmonic distortion (THD) at full linear load when measured from line to neutral with < 3% in any single harmonic, and no third-order harmonics or their multiples.
   d. 2/3 pitch

D. Factory Prototype Test Certified
1. Harmonic Distortion Levels
   a. Demonstrate
2. Airflow Restriction tests
   a. Demonstrate controlled shutdown after overheating
3. Overload Test
   a. Demonstrate 10% overload with no damage to engine
4. Air Filter Test
   a. Demonstrate the engine contains the engine backfire explosion

E. Factory Production Test Certified
1. Alternator Impedance to Ground
2. Dielectric Testing
   a. At two times rated voltage
3. Maximum kW/KVA Rating
4. Engine Response Time
5. Alternator Construction Testing
   a. Impedance Balance Tested
6. Alternator Insulation Testing
   a. Surge Tested

2.3 FABRICATION AND MANUFACTURER

A. Ratings for engine-generator set shall be:
1. Generator Output: as shown on drawings at 0.8 power factor.
2. Voltage: 480V
3. Frequency: 60 Hz
4. Engine: Engine shall be:
   a. Inline or vee-type
   b. Liquid cooled
   c. 4 stroke cycle compression ignition diesel
   d. 1800RPM at rated frequency
   e. Operate on No. 2 domestic fuel oil

B. Engine:

1. Engine shall be:

   a. A compression ignition model for diesel fuel that has been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability. The engine shall be 2 or 4 stroke cycle multi-cylinder design. The engine speed shall not exceed 1800 RPM at normal full load operation when equipped with all necessary operating accessories such as air cleaners, oil pump, water pump, generator, etc. In conformance with the requirements of NFPA 110 Standard for Emergency and Standby Power Systems, the engine shall produce sufficient power to pickup 100% of nameplate kW/kVA rating in one step, less applicable site condition derating factors. Engine ratings shall not exceed the standby power service rating published by the manufacturer.
   b. Operated on No. 2 domestic fuel oil

      1) The fuel system shall be that which is normally used by the diesel engine manufacturer and shall include secondary fuel filter, water separator, manual fuel priming pump, fuel shut-off solenoid, and all piping and appurtenances required for complete system.
      2) Fuel System shall include a fuel transfer pump (if needed to lift the fuel from the sub-base fuel tank) and a replaceable fuel filter element conveniently located for servicing.
      3) Engine shall be capable of operating on low sulfur diesel fuel (less than 15 ppm) without degrading generator output characteristics.

   c. Equipped with electronic speed sensing governor capable of isochronous regulation from no load to full rated load and shall maintain a steady static frequency regulation of +/- 0.25%.
   d. Equipped with emission control equipment per local air board requirements.

      1) Engine generator shall comply with EPA tiered emission requirements (applicable to generator ratings and date of manufacture) in place at time of manufacturer.

   e. Equipped with a lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings and calce rocker mechanism. Full flow oil filters conveniently located for servicing, shall be provided. Lube oil drain extension and valve terminated on the outside of the generator base shall be provided.
   f. Equipped with one or more dry type air cleaner, as recommended by the manufacturer.

C. Engine accessories:

1. Fuel filters, strainer, water separator
2. lube oil filters
3. Intake air filter
4. Lube oil cooler

   a. Suitable for operation of the generator set at full rated load in ambient temperature specified.

5. Fuel transfer pump
6. Fuel priming pump

   a. Engine driven positive displacement, mechanical, full pressure

7. Gear driven water pump
8. Electronic direct fuel injection or have suitable emission control equipment
9. Safety-shut-offs for:

   a. High water temperature
   b. Low oil pressure
   c. Overspeed
   d. Overcranking

10. Provide “Battle Short” settings so that only the overspeed shut-off works when the fire pump and the generator are running simultaneously. Provide signal cable connecting the two.

11. Block Heater
    a. Water Jacket Heater:
    b. Maintain engine jacket water to 110°F in ambient temperature of 30°F
    c. The heater shall be equipped with thermostatic switch.
    d. Single phase 208 volt.
12. Engine cooling system shall be filled with solution of 50/50 mix ethylene glycol at the initial fill.
13. The generator system shall require the following auxiliary power circuits (derived from transformer and panelboard within the enclosure, refer to drawings):
    a. 208V/1Phase for jacket water heater
    b. 120V/1Phase for battery heater
    c. 120V/1Phase for battery charger (for control panel and other misc loads).

D. Generator:

1. Generator shall be:
    a. 480/277 volt, 3 phase, 4 wire 60 Hz (wye connected).
    b. Rated for continuous service in standby applications.
    c. Revolving field type, close-coupled or directly coupled to the engine flywheel. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% overspeed.
    d. Self ventilated.
    e. Windings shall be revolving field coils that are wet layer wound with epoxy based material applied to each layer of magnet wire.
        1) Alternator pitch shall be such to optimize efficiency and minimize total harmonic distortion.
        2) Stator shall have 2 dips and bakes using Class A impregnating varnish.
        3) Stator shall have skewed design for smooth voltage waveform.
        4) Rotor shall be driven through flexible disc coupling to ensure permanent alignment. Rotor shall be dynamically balanced.
        5) Insulation shall be UL 1449 and NEMA-MG1-1.65 Class H insulation and vacuum impregnated with epoxy varnish and shall be fungus resistant.
        6) Two-thirds pitch stator winding and fully linked amortisseur winding shall be provided.
    f. Drip-proof construction.
    g. Designed with maximum subtransient reactance of 12%.
    h. Equipped with permanent magnet brushless excitation.
        1) PMG shall derive excitation current from pilot exciter mounted on rotor shaft. It shall be able to sustain 300% of rated current for 10 seconds during fault condition.
    i. Equipped with digital automatic voltage regulator.
        1) Regulator shall be mounted on top or side of the generator and enclosed in a “NEMA Rated” enclosure. A built-in voltage adjusting rheostat shall provide 10% voltage adjustment. An isolation transformer in the voltage regulator shall be provided.

E. Radiator:

1. Engine skid mounted engine driven radiator with blower type fan, sized to maintain safe operation at 122°F ambient temperature.
2. Radiator shall be equipped with:
    a. Engine driven fan
    b. Initiating contacts to actuate on generator startup.
    c. Core guard
    d. Fan guard

e. Mounting hardware
f. Direct adapter flange. Ductwork with flexible connection between radiator and exhaust plenum shall be provided.
g. Flexible pipe connections at engine and radiator.
h. Engine driven centrifugal water pump and thermostatic valve

3. Engine cooling system shall be filled with solution of 50/50 mix ethylene glycol at the initial fill. System shall be protected against freezing and corrosion.

F. Exhaust System:

1. Furnish critical grade exhaust silencer.
2. Condensate Traps

a. Drain plug at low point of muffler

3. Thermal Expansion

a. Stainless steel exhaust flex to accommodate thermal growth and vibration isolation.

4. Thimble

a. Pipe and wall of compatible construction.

5. Acceptable Back Pressure

a. Silencer and exhaust pipe shall be sized so exhaust back pressure does not exceed maximum limitations specified by generator set manufacturer

G. Exhaust Silencer:

1. Furnish critical grade type exhaust silencer:

a. Sized according to manufacturer's recommendations to reduce engine exhaust noise, refer to generator enclosure section for total required reduction.
b. Silencer and exhaust pipe shall be sized so exhaust back pressure does not exceed maximum limitations specified by generator set manufacturer
c. Mount so weight is not supported by engine
d. Seamless stainless steel flexible exhaust fitting shall be installed on generator outlet.
e. Flanged horizontal inlet and outlet connections
f. Provide drain plug at low point of muffler and low point of exhaust pipe
g. Installation by generator manufacturer within the enclosure.

2. Exhaust piping within the building shall be schedule 40, black steel and shall be insulated.
3. Where exhaust pipe discharges, pipe shall terminate using a ventilated thimble discharge (horizontal discharge with tailpipe 45 degree cut), or vertical discharge with rain cap.

H. Starting System

1. Provide DC electric starting system with positive engagement drive. DC voltage shall be as recommended by the manufacturer.
2. Provide fully automatic start-stop controls.
3. Cycle cranking shall be provided to open and lock out the start circuit after three attempts to start failed engine start.

I. Battery Set

1. Provide sealed lead-acid storage battery set:

a. Heavy duty diesel starting type
b. Voltage compatible with starting system voltage

c. Capacity to provide for one and one-half minutes total cranking time at 0°F without recharging. In accordance with NFPA Level 1.

2. Provide vinyl coated steel battery rack.
3. Provide starting battery heater:

a. Heater plate under battery
b. Heater type blanket around battery case
c. Thermal switch - heater control relay
d. 120 VAC input

4. Battery cables and clamps.

J. Battery Charger

1. Provide constant current, temperature-compensated, and float equalized, dual rate type.
2. Charger shall be solid-state.
3. Charger Accessories:

a. Overload protection
b. +/- 0.5% line and load regulation.
c. Electronic current limit output 105%.
d. DC ammeter and voltmeter digital meter with +/- 2% volt accuracy, +/- 5% amp accuracy.
e. UL 1236 listed and meets NFPA 110 requirements.
f. Output protection.
g. Temperature compensation.
h. Enclosed in NEMA 1 aluminum or stainless-steel enclosure.
i. Form C contacts for the following alarms:

1) General alarm
2) AC fail
3) Low battery volts
4) High battery volts
5) Charger fail
6) Battery fault

4. AC input voltage: 120 volt.
5. When installed on the engine generator set, mount on vibration isolators.

K. Alternator:

1. Maximum temperature rise 105º C at 40º C ambient.
2. Synchronous type.
3. Self ventilated.
4. Drip-proof construction.
5. Directly connected to engine flywheel housing with a flex coupling.
6. 120 Volt Anti-Condensation heater.
7. Subtransient Reactance limited to 12%.
8. Insulation

a. Complies with NEMA (MG1-33.4)
b. Class H Insulation Systems

1) UL 1449 recognized
2) Vacuum impregnated with epoxy varnish
3) Fungus resistant

9. Alternator Components

   a. Solid state design digital voltage regulator:

      1) Performance

         a) Microprocessor based.
         b) Programmable
         c) Regulation: +/- .25% at any constant load for any load from 0% to 100% of pf rating.
         d) Three phase, true RMS sensing
         e) PMG input, engine unloading
         f) A design insensitive to severe, load induced wave shape distortion from SCR or thyrister circuits such as those used in battery charging, UPS, and motor speed control equipment loads.
         g) Controls to limit build-up of AC generator voltage to provide a linear rise and limit overshoot.
         h) Digital adjustments for out voltage adjustment gain, damping and frequency rate–off, and reactive droop adjustment to allow paralleling.
         i) System setup controls and fault alarms.

      2) Protection

         a) Over-excitation protection
         b) Electronic voltage buildup protection.
         c) Loss of sensing protection
         d) Temperature compensation
         e) Limitation of voltage overshoot on startup

      3) Features

         a) Parallel support
         b) VAR/PF control

      4) Environmentally sealed.
      5) UL 508A listing.

L. Controls:

1. NFPA 110 listed.
2. Micro-processor based solid state controls to automatically start, protect and monitor engine-generator set with panel illuminating lighting and digital display.
3. Provide HOA mode selector switch. In the “auto” position, the associated ATS shall control the generator. In the “On” position, the generator with start and run. In the “Off” position, the generator will shut down and remain off. Any HOA switch position other than “Auto” shall generate an alarm signal.
4. Provide Emergency Power Off (EPO) switch flush mounted to the exterior of the enclosure. The EPO switch shall have weatherproof, gasketed, enclosure with lockable, protective shroud to prevent accidental operation.
5. Control panel includes:

   a. Main circuit breaker and Loadbank circuit breaker.
   b. Motor starting switches
   c. Electrically operated fuel control
   d. Relays to disconnect battery charger during cranking
   e. Switching lamps and meters shall be oil tight and dust tight. All active components shall be installed to within a NEMA 3R enclosure. There shall be no exposed components with door open.

f. Protective relays to open circuit breakers and shut down and lockout the engine on abnormal conditions including:

1) Overcrank
2) Overspeed
3) Low lube oil pressure
4) High Engine Temp
5) Operation of Remote Stop
6) Provide "Battle Short" settings so that only the overspeed shut-off works when the fire pump and the generator are running simultaneously. Provide signal cable connecting the two.

g. Monitoring items shall include but is not limited to the following items and control:

1) Coolant temperature.
2) Oil pressure.
3) Battery voltage
4) RPM
5) Voltmeter, 3 ½" dual type, 0.5% accuracy with selector switch.
6) Ammeter, 3 ½" dual type, .05% accuracy with selector switch.
7) Frequency meter, 55-65 Hz +/- 0.125 Hz.
8) Running Time Meter (hours and 1/10 hours).
9) AC power metering shall be 0.5% accuracy and include frequency, phase, selector switch with real time power metering including, KW, KVA, KVAR, KWHR, PF, % of rated load.

h. Control Items:

1) Voltage level adjustment rheostat.
2) Overspeed level adjustment
3) Overvoltage level adjustment
4) Undervoltage level adjustment
5) Overfrequency level adjustment
6) Underfrequency level adjustment
7) Four position function switch marked AUTO, MANUAL RUN, OFF/RESET and STOP.
8) 4 NO and 4 NC dry contacts for local and remote alarms, wired to terminal strips.
9) Emergency off mushroom button.
10) Automatic remote start capability. The engine craning system shall permit at least four cranking attempts of ten seconds (adjustable) duration with rest of periods of ten seconds (adjustable).
11) Overcrack lockout shall occur after four cranking attempts.

i. In accordance with NFPA 110, Level 1, the control panel shall provide battery powered individual visual alarm indicator functions at battery voltage and visual and audible pre-alarm:

1) Overcrank
2) Low water temperature
3) High engine temperature pre-alarm
4) High engine temperature
5) Low lube oil pressure pre-alarm
6) Low lube oil pressure
7) Overspeed
8) Low fuel main tank
9) Low coolant level
10) EPS supplying load
11) Control switch not in automatic position
12) High battery voltage

13) Low cranking voltage
14) Low voltage in battery
15) Battery charger ac failure
16) Lamp test
17) Contacts for local and remote common alarm
18) Low starting air pressure
19) Low starting hydraulic pressure

j. Engine shut down, with audible alarm:

1) Low oil pressure
2) High engine temperature
3) Overcrank
4) Overspeed
5) Remote Emergency Stop
6) Overcurrent (circuit breaker trip and lockout)
7) Reverse power
8) Low-coolant level

6. Visual alarm resettable only after fault condition has been corrected.
7. Audible alarm shall include silencing circuit, which, after activation, will permit annunciation of subsequent failures.
8. Control Panel mounting:

a. Inside enclosure
b. Enclosure shall have clear window for full view of control panel and generator rating without need to open door to enclosure.

9. Provide remote annunciator panel

a. Compliant with NFPA Level 1 requirements. Remote annunciator shall be located in Emergency Electric Room 1040. Provide all cabling from generator to remote annunciator in conduit.

M. Termination Bars and Connections:

1. Silver- or tin-plated copper bus bars for terminating cables.
2. Standard NEMA standard bolt hole spacing, for three phase and neutral, within generator connection box with gasketed bolt on cover.
3. Engine-generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection points shall be provided.
4. Connections to engine-generator set: Flexible or isolation type connections. This shall include electrical, fuel, exhaust, and ventilation connections.

N. Equipment Bases:

1. The complete unit shall be mounted on a structural steel sub-base, rectangular in shape, with sufficient rigidity to maintain alignment of the generator set. Perimeter shall be beams with minimum depth equal to 1/10 of longest dimension of base, except beam depth need not exceed 14” provided that deflection and misalignment are kept within acceptable limits as determined by manufacturer. The engine-generator set shall be statically and dynamically balanced at the factory. The peak-to-peak amplitude of vibration velocity in the horizontal, vertical, and axial direction shall not exceed 0.65” per second at the main structural components.
2. Engine-generator set weight distribution shall be considered to provide uniform deflections.
3. Bases shall provide equipment alignment and assure uniform weight distribution. Provide side brackets on bases to contain isolating mounts and reduce total installed heights of equipment.
4. Contractor is responsible for providing concrete equipment pad, poured to level tolerances as required by equipment manufacturer. Do not rely on concrete floor for level. Note that standard gravity-leveled pads may not be sufficient. Coordinate all requirements with engine generator manufacturer.

5. Connection to pad and enclosure shall be able to resist 131 MPH wind and still maintain operation.

O. Weatherproof Enclosure

1. Provide weather proof, enclosure with Level I sound attenuation for the generator sets. Enclosure shall house control panel, silencer, batteries, charger, step-down transformer, panelboard, etc. The enclosures shall have the following sound characteristics:

   a. Genset shall produce sound at 7 meters or 23 feet of no greater than 85 dBA.

2. Manufacturer shall be responsible for all engineering and work to design enclosure including seismic bracing and calculations and test performance of noise reduction.
3. Enclosure shall integrate sub-base tank.
4. Enclosure shall provide adequate lifting means (i.e. welding lifting rings) such that it can be moved into the site and bolted to concrete housekeeping pads OR removed from the site for repair and maintenance.
5. Enclosure shall have the following features:

   a. Intake hood with screen, capable of resisting the entrance of snow or rain at a maximum wind velocity of 131 MPH. Air intake may require “turn-down” inlet plenum to comply.
   b. LED lighting with 3-way switches pre-wired to the panel.
   c. Battery backup emergency lighting. Charging circuit pre-wired to panel.
   d. Discharge plenum with screen (upblast).
   e. Paint the enclosure to match the existing color of the campus standard. Confirm color chip with owner after bid.
   f. Galvanized steel stairs with hand-rails for steps to each door of the enclosure

P. Vibration Isolators:

1. The engine-generator assembly shall be fastened to a welded steel base which shall allow mounting to a raised concrete pad. Anchor bolts and vibration isolators shall be used to mount the heavy steel base to the concrete pad. Vibration isolators, either integral or external, shall be provided and installed as recommended by the manufacturer. Vibration isolators shall be one-piece units resistant to corrosion and environmental degradation. When sub-base tanks are specified, vibration isolators shall be located between the generator set and the fuel tank.

Q. Sub-base Fuel Tank:

1. Provide double-walled sub-base fuel tank installed beneath the walk-in enclosure as one integrated assembly. The fuel tank shall be mounted in a rupture basin. The fuel tank shall be listed and labeled to UL 142 and meet the requirements of NFPA 37 for the tank vent.
2. The sub-base tank shall be sized for a minimum of 56 hours of generator operation at full load.
3. Provide high and low-level switches to turn off/on remote supply pumps.
4. Provide a flow restrictor into the tank.
5. Provide leak detection for the inner wall tied to an alarm panel with a horn and a red warning light.
6. Provide 2 solenoid valves at the inlet to the tank. 1 NC 120-volt AC valve, 1 NO 120 volt valve for critical high level to shut off.

R. Circuit Breakers:

1. Refer to the drawings for specific requirements of the generator mounted circuit breakers including construction type, frame and sensor plug ratings, and trip unit characteristics. Circuit breakers shall be service entrance rated where indicated on the drawings.
2. Provide 100% rated molded case circuit breakers with fully adjustable electronic trip unit characteristics (except for the fire pump) as described below. The circuit breaker for the fire pump shall be magnetic-only type per NCSCO requirements.
3. Thermal-Magnetic Circuit Breakers: inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting.

4. Fixed circuit-breaker mounting
5. Auxiliary Contacts: 1 SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit breaker contacts, "b" contacts operate in reverse of circuit breaker contacts.
6. Control Voltage: 24V derived locally.
7. Listed for 100% of breaker's continuous ampere rating.
8. Circuit Breaker Electronic Trip Units general characteristics:
9. Circuit breakers, with solid-state microprocessor based trip units.
    a. Unit shall consist of current sensors, solid-state trip device, and solid-state adjustable time/current curve shaping elements.
    b. Trip units shall be removable to allow for field upgrades.
    c. Trip units shall incorporate "True RMS Sensing."
10. Solid-state elements shall provide functions as indicated above.
11. Adjustments shall be made using non-removable, discrete steps.
12. Sealable transparent cover shall be provided over adjustments.
13. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL listed as field-replaceable. Adjustable rating plug shall allow for 9 long-time pickup settings from 0.4 to 1.0 times sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match application. Long-time delay settings shall be in 9 bands from 0.5-24 seconds at 6 times Ir.
14. Short-time pickup shall allow for 9 settings from 1.5 to 10 times Ir. Short-time delay shall be 9 bands from 0.1-0.4 I2t ON and 0-0.4 I2t OFF.
15. Instantaneous settings on the trip units shall be available in nine bands from 2 to 15 times In.
16. Ground Fault alarm:
    a. Ground-fault alarm protection with at least 3 short-time-delay settings and 3 trip-time-delay bands; adjustable current pickup.
    b. Alarm shall be provided as an integral part of breaker.
    c. Pick-up shall be adjustable with maximum setting of 1200 amps. Circuit breakers below 1200A shall be in 9 bands from 0.2 to 1.0 times In.
    d. Time delay shall be adjustable.
    e. Neutral current transformers shall be provided for 4-wire system.

2.4 INTERFACE WITH BUILDING AUTOMATION SYSTEM (BAS)

A. Interface shall be as follows:

1. Control panel shall incorporate communication module with communication port connection to building automation system (BAS) via Modbus. Generator manufacturer shall furnish all cabling and interface components for communication and Contractor shall install that cabling. Contractor's installing electrician shall provide work to install cabling and terminate at generator and BAS cabinet. Contractor shall provide work to modify BAS programming to interface with generator system. Contractor shall ultimately be responsible for all communication, scheduling, etc. such that his "team" provides all work for this communication.
2. Communications shall match existing generator communications and include, but is not limited to, the following:

TYPE	CONDITION/DESCRIPTION
LDI 1	Generator general prealarm – tied to all prealarms
LDI 2	Battery charger AC failure
LDI 3	Control switch not in automatic position
LDI 4	EPS supplying loads
LDI 5	Generator general alarm– tied to all alarms
LDI 6	Sub-base fuel storage leak
LDI 7	Low fuel level in sub-base tank

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install engine-generator set and associated equipment as indicated. Coordinate final location of equipment with General Contractor. Final location of equipment to be reviewed with Designer prior to installation.

B. Equipment shall be installed in accordance with manufacturer's recommendations. Provide equipment protection during and subsequent to installation.

C. Contractor shall provide electrical connections to all accessories such as: remote annunciator.

D. Contractor shall provide all 600V (expect signal/controls cabling) exterior to the generator.

E. Generator manufacturer shall provide all cabling, connections, terminations, etc. internal to the enclosure as an integrated assembly. Contractor shall provide all signal/controls cabling external to the enclosure for remote annunciator and interface with the ATSs and BMS system. The signal/controls cabling shall be installed by the Contractor's installing electrician.

3.2 ACCEPTANCE TESTS

A. Acceptance Testing to be performed in accordance with Section 260801 as well as in conjunction with the system functional testing with automatic transfer switches. The intent is to test the generator separately and then as an integrated system with the ATSs. The generator manufacturer is responsible for all testing. The Contractor shall provide start-up testing support for the duration of the testing and shall schedule all testing. The Contractor shall be responsible for rental and connections of loadbank. Loadbank shall be resistive/reactive type to match full rating of generator.

B. Provide test script plan for the site acceptance testing for approval at least 14 days prior to the test. The test script plan shall include all required testing per this specification in addition to standard manufacturer testing.

C. Engage a factory-authorized service representative to test, inspect, adjust generator system components and perform start-up report.

D. Test generator per requirements and guidelines of NFPA 110. Provide certified report with closeout submittals.

E. All site testing shall be performed at the jobsite in the presence of the Owner, Designer, and Commissioning Agent. A full tank of fuel shall be provided, replacing any fuel used for testing. Diesel fuel shall be treated with an alcohol-free additive to disperse water and clean injectors.

3.3 LOAD TEST

A. Contractor shall conduct load testing of engine-generator set, under direct supervision of factory authorized representatives of manufacturers of engine-generator set, fuel management system, paralleling switchgear, and auto-transfer switches. All test results shall be reviewed, approved, signed by the manufacturer's representative.

B. Loading shall be by use of resistive/reactive load bank connected to generator loadbank breaker/termination cabinet. Note that each generator shall be 100% load tested with a resistive/reactive load bank at the factory as part of the factory testing prior to shipment. All factory test results shall be submitted by the manufacturer.

C. Provide certified results of testing, including frequency and voltage regulation at 25, 50, 75 and 100% of rated load for 1 hours at each load level, fuel consumption at the above load ratings, actual measured values for pickup and drop out relays for the ATS, measured values for time delay relays. Record the following data every 15 minutes:

1. Voltage
2. Amperage
3. Frequency
4. kW
5. kVA
6. oil pressure
7. Coolant temperature
8. Fuel consumption

D. Provide certified results of testing, including frequency and voltage regulation and transient response at 50% step load and unload. Repeat test.

E. Provide certified results of testing, including frequency and voltage regulation and transient response at 90% step load and unload. Repeat test.

F. Test battery system per manufacturer's written recommendations. This includes at a minimum: equalize charging of cells, charge voltage, conductance/resistance, battery terminals, recharge time.

G. Test each battery charger system per manufacturer's written recommendations. This includes at a minimum: rate of charge (each type), operation of alarms.

H. Test generator overload sequence of operations without harm to the equipment.

I. Test and confirm automatic generator loading and unloading as controlled by associated ATS.

J. Test loadbank breaker shunt trip operation.

K. Test and confirm operation of all alarms, EPO, etc at the control panel as well as remote signaling to ATS and BAS system.

L. Engine-generator set test results shall be certified to comply with specification parameters or necessary corrective actions implemented and tests repeated until compliance is certified.

M. At conclusion of testing, engine-generator set shall be serviced including replacing air, oil and fuel filters, changing lubrication oil, checking and refilling batteries, adjusting fan belts for proper tightness, and refilling of cooling system as required.

N. Contractor shall provide fuel for load testing of engine-generator set and fill all tanks upon final acceptance.

3.4 WARRANTY

A. The emergency generator, transfer switch and associated equipment shall be warranted by the manufacturer for a period of five (5) years, from the date of final inspection and acceptance. The warranty shall be included in the contract document. The warranty shall include all parts, labor (including travel), expenses and equipment necessary to perform replacement and/or repairs.

3.5 DOCUMENTATION AND TRAINING

A. Prior to final acceptance, the manufacturer shall supply three (3) copies of complete instruction manuals to the owner. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings. The technical literature shall include a manual of sequential operations, recommended preventative maintenance, parts list with recommended spares, and all pertinent controls manuals and wiring diagrams.

B. Engage factory service technician for manufacturer equipment start-up and training tailored to this project. Provide one-day, 8-hour equipment training session. This includes individual generator operation and maintenance as well as ATS system operation, functionality, and maintenance. Provide written, detailed training plan for approval at least 14 days prior to scheduled training. Owner reserves right to modify and augment training plan as desired. Videotape that training and provide DVD to owner with O&M manuals.

END OF SECTION 263213

SECTION 263623 - AUTOMATIC TRANSFER SWITCH

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 DESCRIPTION OF SYSTEM

A. Provide automatic transfer switch, 3 phase, 60 hertz, 4 pole, for voltage and current as indicated on drawings. ATS shall be front-access-only, bypass isolation, open-transition type with delay transition transfer option to provide time delayed disconnect from both input sources. ATS shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation.

B. The ATS shall have a utility-generator programming configuration. The intent is for the operator to select which source to transfer to automatically or manually and toggle on/off automatic retransfer to Primary Source upon power restoration after a disruption.

C. Provide remote annunciator control station to allow for safe manual transfer between sources. The ATS shall have all relay logic necessary to communicate source availability and source connected to the BAS. Provide all work to make that connectivity, and programming of the BAS for remote monitoring only. The ATS shall be capable of being monitored and controlled from the remote control wallstation.

1.3 REFERENCE STANDARDS

A. ICS 10 Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment.

B. UL1008 Automatic Transfer Switches.

C. UL 891 According to this UL standard the equipment shall be labeled: “Suitable for use only as service equipment.”

D. UL 508 Industrial Control Equipment

E. NFPA 50 – National Electrical Code

F. NFPA 99 - Essential Electrical Systems for Health Care Facilities

G. NFPA 110 - Emergency and Standby Power Systems

H. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

1.4 SUBMITTALS

A. Cover letter with compliance table listing each specification section and indicating compliance “C”, deviation for alternate “D”, or exception with explanation “E”. Any deviation or exception shall be accompanied with detailed explanation of how design intent is being upheld.

B. Submit Shop Drawings for equipment provided under this Section.

1. General Arrangement:

a. Indicate front, plan, and side views of ATS; access requirements (front, side, rear); overall dimensions and components list; shipping splits and weights.
b. Front elevation indicating location of devices and instruments.
c. Sections through ATS showing space available for conduits.

1) Conduit entrance locations and requirements.
2) Nameplate legends.
3) Configuration, size and number of bus bars for each phase and current rating of buses.
4) Ground bus.
5) Short circuit ratings of overcurrent protective devices, and bus withstand rating.
6) Instrument details; enclosure types and details.
7) Wiring diagrams: power, signal and control wiring.

C. Closeout Submittals:

1. Project Record Documents:

a. Record actual locations, configurations, and ratings of major components on single-line diagrams and plan layouts.

2. Operation and Maintenance Data:

a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
b. Include manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Include spare parts data listing, source, and current prices of replacement parts and supplies.
d. Include time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn't available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment".

B. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. There shall be a service center within 100 miles of project site. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

C. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

D. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

E. Obtain ATSs from one source and by single manufacturer.

F. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 WARRANTY

A. Refer to Division 1 and Section 26 0000 – General Electrical Requirements for general guarantee requirements.

B. Manufacturer shall provide standard 1yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin upon acceptance of the facility completion in accordance with 2016 State Construction Manual Section 709 and NCGS 133-1.1b

PART 2 - PRODUCTS

2.1 MATERIALS

A. Acceptable Manufacturers:

1. ASCO
2. Russelectric
3. Cat

2.2 AUTO-TRANSFER SWITCH

A. Auto-transfer switch shall be:

1. Mechanically held, electrically operated type.
2. Rated for continuous duty in unventilated sheet metal enclosure.
3. Suitable for all classes of loads at maximum rated voltages.
4. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the circuit breaker rating as shown on the plans. The ATS shall be UL listed in accordance with UL 1008 and be labeled.

B. Main contacts shall be silver alloy wiping action type protected by arcing contacts.

C. The ATS shall be provided with fully rated neutral contacts.

D. Switch components shall be accessible from front of enclosure.

E. Provide 3 cycle short circuit rating of 50 kAIC.

F. Provide switch with the following items:

1. Full phase protection consisting of 2 phase relays and one close differential relay.
2. Pushbutton reset to normal.
3. Pushbutton/switch to bypass time delay on retransfer to Primary Source.
4. Pilot light to indicate Primary Source position.
5. Pilot light to indicate Alternate Source position.
6. Auxiliary contact to close when Primary Source power fails.
7. Auxiliary contact to open when Alternate Source power fails.
8. Auxiliary contact on same shaft as main contacts (closed on Primary Source).

9. Auxiliary contact on same shaft as main contacts (closed on Alternate Source).

2.3 CONTROLLER

A. The controller's sensing and logic shall be provided by a single built-in microprocessor with the ability to communicate serially through an optional serial communication module. The control module shall direct the operation of the transfer switch. The control settings shall be stored in nonvolatile memory.

B. Voltage sensing shall be true RMS type and shall be accurate to ± 1% of nominal voltage. Frequency sensing shall be accurate to ± 0.2%. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.

C. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit.

D. All customer connections shall be wired to a common terminal block.

E. Controller Display and Keypad:

1. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

   a. Nominal line voltage and frequency
   b. Single or three phase sensing
   c. Operating parameter protection
   d. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

F. Voltage, Frequency and Phase Rotation Sensing:

1. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

		DROPOUT					PICKUP				
TDNE	TDEN	OV	UV	OF	UF	UB	OV	UV	OF	UF	UB
10 seconds	10 minutes	528	408	62	58.5	10%	518	432	60.5	59.5	9%

TDNE= TIME DELAY TRANSFER TO ALTERNATE SOURCE
TDEN= TIME DELAY RETRANSFER TO PRIMARY SOURCE
OV= OVERVOLTAGE
UV= UNDERVOLTAGE
OF= OVERFREQUENCY
UF= UNDERFREQUENCY
UB= VOLTAGE UNBALANCE
DROPOUT= WHEN SOURCE IS CONSIDERED BAD
PICKUP= WHEN SOURCE BECOME ACCEPTABLE

2. Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.
3. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
4. The controller shall sense the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
5. Source status screens shall be provided for both normal & emergency showing digital readout of voltage on all 3 phases, frequency, and phase rotation.

G. Time Delays

1. A time delay shall be provided on transfer to Alternate Source, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads between sources.
2. Two-time delay modes (which are independently adjustable) shall be provided on re-transfer to Primary Source. One-time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

H. All time delays shall be adjustable in 1 second increments. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.4 DATA MONITOR

A. Provide data meter/monitor system located inside ATS cabinet, readable from front of enclosure.

B. The data monitor system shall be listed to UL 3111-1 and industrially rated for an operating temperature range of -20°C to 60°C.

C. The data monitor system shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

D. The data monitor system shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32VDC.

E. The data monitor system shall be capable of interfacing with a communications module to permit information to be sent to paralleling swithgear for display, analysis, and logging.

F. The data monitor system shall accept inputs from industry standard instrument trans-formers (120 VAC secondary PT's and 5A secondary CTS.) Direct phase voltage connections, 800 VAC and under, shall be possible without the use of PT's.

G. The data monitor system shall be applied in four-wire circuits. A fourth CT input shall be available to measure neutral or ground current.

H. All setup parameters required shall be stored in non-volatile memory and retained in the event of a control power interruption.

I. The following metered readings shall be communicated (for both sources), via serial communication, with serial communications module:

1. Current, per phase RMS and neutral
2. Current Unbalance %
3. Voltage, phase-to-phase and phase-to-neutral

4. Voltage Unbalance %
5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency

J. The data monitor system shall be equipped with a continuous duty, 4-line x 20 character LCD backlit display to provide local access to the metered quantities as described above. Displaying each of the quantities shall be accomplished through the use of menu scroll buttons.

2.5 ENCLOSURE

A. The ATS shall be provided in a Type 1 enclosure.

B. All standard and optional door-mounted switches and pilot lights shall be 8mm to 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

2.6 ACCESSORIES AND FEATURES

A. The ATS positions shall be:

1. a) Off - Allows all enabled accessories to be monitored only. Settings cannot be changed while in this position.
2. b) Local - Allows all enabled accessory settings to be changed locally at the transfer switch control panel
3. c) Remote - Allows all enabled accessories to be altered via the remote communications port.

B. Generator exercising time switch with load/no load selector switch.

C. Transfer time not to exceed one-sixth (1/6) second.

D. The normal and emergency contacts shall be positively interlocked, mechanically and electrically, to prevent simultaneous closing. The main contacts shall be mechanically locked into position for both the normal and emergency positions without the use of hooks, latches, magnets or springs.

E. In-phase monitoring shall continuously monitor the contactor transfer times, source voltage, frequency and phase angle to provide a self-adjusting, zero crossing contactor transfer signal.

F. Anti-single phasing protection shall detect regenerative voltage as a failed source condition. A three-position momentary-type test switch shall be provided for the test/automatic/reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer Alternate Source or retransfer to Primary Source.

G. The following features shall be built-in to the controller, but capable of being activated through keypad programming:

1. Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the Alternate Source if the Primary Source restores before the Alternate Source is ready to accept the load.

2. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to Alternate Source and for remote contacts which open to inhibit transfer to Alternate Source and/or retransfer to Primary Source. Both of these inhibit signals can be activated through the keypad or serial port.
3. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

H. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position.

I. Self-Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

J. Communications Interface – The controller shall be capable of interfacing, through a serial communication module remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.

K. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:

1. Event Logging

   a. Data and time and reason for transfer normal to emergency.
   b. Data and time and reason for transfer emergency to normal.
   c. Data and time and reason for engine start.
   d. Data and time engine stopped.
   e. Data and time emergency source available.
   f. Data and time emergency source not available.

2. Statistical Data

   a. Total number of transfers.
   b. Total number of transfers due to source failure.
   c. Total number of days controller is energized.
   d. Total number of hours both normal and emergency sources are available.

L. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices.

2.7 SEQUENCE OF OPERATION

A. Source drops below a range of 70-95% of rated voltage (factory set at 85%) after an adjustable time delay period of .05 to 6 seconds (factory set at 3 seconds) to allow for momentary dips. The transfer switch shall transfer to emergency as soon as the generator voltage has reached a range of 75-100% of rated voltage (factory set at 90%) and generator rated frequency of 85-100% (factory set at 90%).

1. After restoration of normal power on all phases to 90% of rated voltage, an adjustable time delay period of 0-30 minutes (factory set at 5 minutes) shall delay re-transfer to normal power until it has stabilized. If the emergency power source should fail during the time delay period, the time delay shall be by-passed and the switch shall return, immediately, to the normal source.

2. After the switch has transferred to normal, the engine generator shall be allowed to operate at no load for 5 minutes to allow it to cool before shutdown. The engine cool-down timer may be installed in the generator control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

B. Provide equipment protection during and subsequent to installation.

C. Install ATS in accordance with applicable portions of ANSI/NECA 400.

D. ATS mounting and seismic restraints:

1. Bolt ATS to concrete housekeeping pads, using anchor bolts in accordance with manufacturer's recommendations. Cast anchor bolt inserts into pads.

E. Install engraved plastic nameplates under provisions of Section 260553. Attach nameplate to exterior of ATS using small corrosion-resistant metal screws and rivets. Do not use contact adhesive.

F. Provide printed operating instructions for ATS, including control and key interlocking sequences and emergency procedures. Cover instructions with clear acrylic plastic.

G. Tighten electrical connectors and terminal according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

H. Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 CONNECTIONS

A. Ground ATS according to Section 260526.

B. Connect power and control wiring according to Section 260519.

3.3 FIELD QUALITY CONTROL

A. Inspect ATS for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Test continuity of each circuit.

C. Test ATS per requirements in Sections 260801 and per the sequence of operations as detailed on the drawings.

D. Provide start-up and testing per manufacturer's recommended practice.

E. Interpret test results in writing and submit to Designer. Correct and retest as required and provide new test results until within the manufacturers and specifications criteria.

3.4 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.5 ADJUSTING

A. Set field-adjustable circuit breakers trip settings, to values indicated recommended by the overcurrent protective device coordination study.

3.6 CLEANING

A. Clean ATS during construction phase, prior to initial testing and energization, and prior to final punch list, after other trades have departed. Cleaning procedures shall be as follows:

1. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.
2. Rack out ATS.
3. Wipe down surfaces, and parts per manufacturers written recommendations
4. Use paintbrush to dust small, hard-to-reach crevices.

3.7 DEMONSTRATION

A. Provide training session by manufacturer for one workday (4 hours) at a job location, to train the Owner's personnel in the operation and maintenance of switchgear. This training shall be separate from paralleling switchgear training but shall take place during that training window.

3.8 FACTORY TESTING AND QUALITY ASSURANCE INSPECTION

A. The equipment shall be factory tested to simulate a complete and integrated system. A certified factory test report shall be furnished to verify system testing.

B. The ATS shall be subjected to the factory testing and quality control inspections to insure reliable operation. These tests and inspections shall include, but not necessarily be limited to, the following:

1. Perform a megger test with a 1000-volt megger. The minimum acceptable megger reading shall be 100 megohms on the ATS and contactors in the open position.
2. Insulation tests of all equipment and wiring, buses, etc., in accordance with manufacturer's standard practice.
3. Circuit continuity and wiring.
4. Mechanical equipment adjustment and operation of all moveable equipment and devices.
5. Equipment arrangements, types, and ratings for conformance with approved drawings.
6. Bus bar phasing and bracing.
7. Integrity of all electrical connections.
8. Conformity with the nameplate and circuit identification indicated on the Drawings and the approved manufacturer's drawings.
9. Demonstration of all ATS Functions.

3.9 FACTORY TESTING AND QUALITY ASSURANCE INSPECTION

A. A factory authorized technician shall be present during start-up and commissioning of the ATS and shall participate in that effort including the integrated testing of the ATS with the remote communication to the BAS.

3.10 WARRANTY AND SERVICE

A. ATS manufacturer warrants the equipment to be free from defects in material and workmanship. Manufacturer shall provide standard 1-year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin upon acceptance of the facility completion in accordance with 2016 State Construction Manual Section 709 and NCGS 133-1.1b.

B. ATS manufacturer shall have an established network of factory owned and operated service centers within the continental US capable of servicing the specified equipment.

C. The manufacturer's personnel shall be on call 24 hours a day, 7 days a week. Personnel shall be factory trained and certified in the maintenance and repair of the specified equipment.

D. After-warranty service contracts shall be available to the owner by the manufacturer to provide periodic maintenance and/or repair of the specified equipment.

3.11 OPERATION AND MAINTENANCE MATERIALS

A. Operation Instructions and Maintenance Manuals:

1. After completion of work and start-up of the equipment at the project site, deliver to the Owner's Representative, (3) copies of operation instructions, maintenance manuals and drawings presenting full details for care and maintenance of each item of equipment provided under this Contract.
2. Each manual shall contain the operating and maintenance information and parts lists for all equipment provided under this Contract. When necessary, provide supplemental drawings to show system operation and servicing and maintenance points. For all electrical components, provide wiring and connection diagrams. Manuals shall include instructions required to accomplish specified operation and functions. Data shall be neat, clean, legible copies.
3. ATS drawings and wiring diagrams shall be included and up to date at the completion of start-up and system acceptance by the Owner. Drawings and wiring diagrams shall include any field modifications or changes to reflect actual as installed conditions.
4. In general, the manual shall include, but not necessarily be limited to, the following:

   a. ATS Elevation & One Line
   b. AC & DC Schematic and Physical Component Layout Drawings
   c. Remote Interface drawing
   d. Bill of Material
   e. ATS Operation Manuals
   f. Description of Operation
   g. Recommended Spare Parts List - showing all consumables anticipated to be required during routine maintenance and testing.

B. Manuals shall be in the form of three-ring binders and compact discs (CDs) adequately labeled with the project name and location and the contents indexed. Three (3) sets of manuals and three (3) sets of compact discs (CDs) shall be provided to the Owner's Representative.

3.12 OPERATION

A. Refer to 260801 for additional information.

3.13 ACCEPTANCE TESTING

A. Acceptance testing shall be performed in accordance with Section 260801.

B. Confirm sequence of operations with engineer and commissioning agent.

C. All equipment shall be given complete operational tests to ascertain that all design functions are satisfactorily performed. Testing shall include:

1. Actuation of all alarm indication devices.
2. All control circuits, automatic operations and interlocks shall be tested under simulated operating conditions.
3. All of the above shall be tested according to design specifications for correct and positive operations.

D. It shall be the responsibility of the installing contractor to verify that the following items have been completed and are ready to perform as specified before the arrival of the start-up technician.

1. Inspect for obvious shipping damage.
2. The ATS is installed, anchored down and grounded.
3. Terminate all power cables.
4. Install customer control wiring to external equipment.

E. The start-up technician shall perform the following items:

1. Verify contractor connections, control power availability, visually inspect any relay settings.
2. With the generator technical representative controlling the system, verify that the ATS and control equipment are fully operational and perform per the sequence of operation specified.
3. With the generator supplier's technical representative controlling the system, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the Designer and commissioning agent.
4. Provide documentation in the form of function checklists and recorded data for each section to the Designer.

F. Engage factory service technician for manufacturer standard equipment start-up and training. Provide 4-hour equipment training session. Videotape that training and provide DVD to owner with O&M manuals.

END OF SECTION 263623

SECTION 264300 - SURGE PROTECTIVE DEVICES (SPDs)

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 DESCRIPTION

A. Provide Surge Protective Device (SPD) system. Specified system shall be Type 1 to provide high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments. All SPDs shall be UL 1449 3rd edition listed. An upstream overcurrent protective device SHALL NOT be required to obtain listed rating of SPD.

B. Refer to the drawings for location of SPDs.

C. Coordinate with the Lightning Protection System on submittals and installation in order to comply with all UL 96A criteria.

1.3 REFERENCE STANDARDS

A. ANSI C62.41 Recommended Practice for Surge Voltage in Low-Voltage AC Power Circuits.

B. ANSI C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.

C. UL 1449 UL Standard for Safety for Surge Protective Devices Third Edition or newer

D. UL 1283 Electromagnetic Interference Filters

1.4 SUBMITTALS

A. Submit shop drawings showing unit dimensions, detailed installation instructions, recommended replacement parts list and wiring configuration for equipment.

B. Equipment datasheets and documentation showing compliance with this specification.

C. Documentation of Voltage Protection Rating (VPR), surge current capacity, and noise rejection testing, for all modes of protection for each SPD module being submitted per section 1.6.

D. Copy of warranty statement.

1.5 QUALITY ASSURANCE

A. Provide test report copies of the following:

B. Perform let through voltage testing for ANSI/IEEE C62.41 Category C3 (combination wave) in accordance with ANSI C62.45.

C. Perform Noise Rejection testing as outlined in NEMA LS1-1992. Noise rejection is to be measured between 10 kHz and 100 MHz verifying the devices noise attenuation.

D. Perform surge current testing which produces the listed surge current waveforms for the device, verifying the suppressor components can survive published surge current rating on a per mode basis. Calculated results are not acceptable.

1.6 WARRANTY

A. Manufacturer shall provide minimum 10-year warranty. Warranty statement shall clearly establish the terms and conditions to the owner. Warranty period shall begin upon acceptance of the facility completion in accordance with 2016 State Construction Manual Section 709 and NCGS 133-1.1b

PART 2 - PRODUCTS

2.1 MATERIAL

A. Acceptable manufacturers for externally mounted SPDs:

1. Current Technology
2. Liebert
3. Surge Suppression Inc.

B. Acceptable manufacturers for internally mounted SPDs:

1. ABB
2. Eaton
3. Square D

2.2 PERFORMANCE CHARACTERISTICS

A. Listed as a Type 1.

B. Operating voltage and frequency: Refer to the drawings.

C. Maximum Continuous Operating Voltage (MCOV): ≤115% of the nominal system operating voltage and as indicated in this specification.

D. Response time: ≤ 1 nanoseconds for all modes of protection.

E. EMI/RFI noise rejection high-performance filter: ≤ 50 dB across frequency spectrum.

F. Modes of Protection:

1. 4-wire system with the following 10 modes of protection: L-L, L-N, L-G, N-G
2. 3-wire system with the following 7 modes of protection: L-L, L-G

G. Nominal discharge surge current rating: 20kA

H. Minimum single pulse surge current capacity/mode based on 8 x 20 microsecond current waveform (unless noted otherwise in the drawings) shall be:

1. Service Entrance Switchgear: 240kA
2. Distribution Switchboards (≥800A): 160kA

3. Panelboards: 100kA

I. Category C3 Sequential Surge Current Survivability:

1. ≥10,000 sequential category surges without failure.

J. Fault Current (SCCR) Rating: 200kAIC (without the use of circuit breaker or fuse on ahead of SPD).

K. Voltage Protection Rating (VPR):

System Voltage	Mode	MCOV	UL 1449 VPR Rating (6kV/3kA combination ring wave)
208/120V	L-N	150	700
	L-G	150	700
	N-G	0	900
	L-L	300	900
480/277V	L-N	320	1000
	L-G	320	1200
	N-G	0	1200
	L-L	550	1800

2.3 OPERATING CONDITIONS

A. Temperature range: -40°C to +50°C (-40°F to 122°F).

B. Relative humidity range: 0 to 95%, non-condensing.

2.4 FABRICATION

A. SPD Modules:

1. External SPD modules shall consist of:

a. Multiple gap-less, individually fused MOVs.

B. Monitoring Diagnostics:

1. Provide audible and visual alarm. Alarm shall be activated under any SPD fault condition. There shall be an alarm silence button.
2. Provide form C dry contacts (NC and NO) for capability of remote alarm communication. Provide all work for remote signal to BAS system upon alarm.
3. The status of each MOV shall be monitored. Provide indicator LEDs to report the protection status of each mode. One color (i.e. green) LED indicates normal operation and different color LED (i.e. red) shall indicate damage has occurred and the SPD should be replaced.
4. Provide LED to indicate SPD is working and receiving power.
5. Monitoring shall be electrically isolated from the protected power supply.
6. Measuring capability to indicate the percent of MOV protection remaining in SPD. Send alarm if more than 20% MOVs have failed.
7. Provide surge “event” counter visible from outside of SPD cabinet.

C. Internal Connections:

1. Inter-unit connections shall utilize low impedance plated busbars or conductors.

2. No plug-in component modules or printed circuit boards shall be used as surge current conductors. No small gage round wire or plug-in connections shall be used as surge current carrying conductor.
3. All internal components shall be soldered or hardwired.

D. External SPD Enclosure:

1. Heavy-duty
2. Watertight
3. Dust tight
4. No ventilation openings

E. Disconnect Means:

1. External SPD: Magnetic circuit breaker in distribution equipment with parallel type connection. Rating/size of that disconnecting device shall be per SPD manufacturer recommendation if larger than indicated on the drawings.

F. Integral Disconnect Switch for external SPD:

1. The device shall have a NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
2. The switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
3. The integral disconnect switch shall be capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

PART 3 - EXECUTION

3.1 APPLICATION OF SPD

A. Install parallel type SPD on load side of Service Entrance switchgear. This shall be an external type mounted in a compartmentalized cabinet inside the back of the switchgear as close as possible to the busbar to minimize cable length.

B. Install parallel type SPD on load side of Distribution Switchboards as shown on the drawings. This shall be internal type.

C. Install parallel type SPD on load side of panelboards as shown on the drawings. This shall be internal type.

3.2 INSTALLATION

A. Install per SPD manufacturer's written recommended practices.

B. Install parallel type SPD with #1 AWG minimum conductors.

C. Provide branch circuit breaker for SPD sized per manufacturer's written recommendation. This coordination shall be the responsibility of the Contractor.

D. Conductors for external SPD shall be short and straight and shall not exceed 3 ft in length. Conductors that exceed 3ft in length shall be recognized as "low-capacitance" cable.

E. Input conductors twisted together to reduce inductance.

F. Avoid 90-degree bends in cable.

3.3 FIELD QUALITY CONTROL

A. Inspections before SPD startup:

1. Visual Inspection:

a. Verify installation per drawings and submittal datasheets.
b. Verify phase, neutral, and ground conductors are properly sized and configured.

2. Mechanical Inspection:

a. Check all connections for tightness.
b. Check terminal screws, nuts and/or connectors for tightness.

3. Electrical Inspection:

a. Confirm input voltage, frequency, and wiring configuration.
b. Confirm phase, neutral and ground connections are proper.
c. Confirm monitoring diagnostics features
d. Confirm controls connection to energy management system.

END OF SECTION 264300

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 260000 – General Electrical Requirements

B. Section 260519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 260526 – Grounding and Bonding for Electrical Systems

D. Section 260533 – Raceway and Boxes for Electrical Systems

E. Section 260923 – Lighting Control Devices

F. Section 260936 – Modular Digital Lighting Control Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF WORK

A. Provide complete and fully operational lighting system per Contract Drawings and Specifications.

B. Luminaires shall be provided complete with necessary accessories for proper installation.

C. Catalog numbers shown in design luminaire schedule shown on sheet E-600 are used to establish the specification and are not intended to be complete for ordering purposes. Additional features, modifications, accessories, and options as described or necessary for proper installation per the drawings are to be included.

D. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.

E. Work includes final aiming and focusing of luminaires under direction of the Architect/Lighting Designer.

1.4 REFERENCE STANDARDS

A. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems (ANSI)

B. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems (ANSI)

C. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems (ANSI)

D. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility

E. UL 773 - Plug-in Photocontrols for use with area lighting

F. UL 924 - Emergency Lighting and Power Equipment

G. UL 1574 – Track Lighting

H. UL 1598 – Luminaires

I. UL 1838 – Low Voltage Landscape Lighting Systems

J. UL 2108 – Low Voltage Lighting Systems

K. UL 2388 – Flexible Lighting Products

L. UL 2562 – Pendant Cable

M. UL 8750 – LED Light Sources for use in Lighting Products

N. ANSI C78.377 – Chromaticity

O. IESNA LM-79 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

P. IESNA LM-80 - Approved Method: Testing Lumen Maintenance of LED Light Sources

Q. IESNA TM21-11 - Projecting Long Term Lumen Maintenance of LED Light Sources including Addendum A

1.5 QUALITY ASSURANCE

A. Luminaires, drivers, other components shall meet the requirements of all applicable State and Municipal codes and energy codes.

B. Provide luminaires listed and labeled by UL or other testing lab acceptable to local jurisdiction for their indicated use and installation conditions.

C. Contractor shall coordinate installation of lighting systems with all trades.

1. Manufacturers listed in the luminaire schedule shall be assumed capable of supplying listed luminaires. Any such exceptions shall immediately be brought to the attention of Architect, Engineer, or Lighting Designer.
2. The Electrical Contractor shall choose which of the listed products are to be provided except that all types indicated as part of a family or indicated to match shall be from the same manufacturer.
3. Single Name Specification:

a. When only one product is suitable for the application and/or no other known acceptable products exist, only one manufacturer/product is listed in the Luminaire Schedule. For such instances, Electrical Contractor shall provide the listed product with no exceptions.

4. Contractor shall coordinate and verify compatibility of luminaires with lighting control system

   a. Control protocol indicated for luminaires matches protocol of lighting control system specified. Contractor shall coordinate and verify compatibility of all dimming luminaires with control system to ensure that dimming is flicker free, continuous dimming through the dimming range noted on the luminaire schedule.

D. Substitution requests:

1. Shall be made not less than 10 days prior to bid date and will be evaluated prior to Bid.
2. When requesting a substitution, Electrical Contractor shall provide a guaranteed savings to owner to be realized by accepting proposed alternate for each substituted item.
3. Approved substitutions which are successfully bid are still subject to full submittal during the construction phase following the procedures set forth in this Section under paragraph 1.7 and in Section 01 2500 - Substitution Procedures.
4. Product Data and a working Sample are required to evaluate suitability of proposed substitution. Refer to sample requirements in paragraph 1.7 of this Section.
5. Samples shall:

   a. Be fully operable, complete with specified LED modules and with functioning cord and plug ready for installation. A demo-case sample may be acceptable if configured to meet specified requirements and accurately depict housing and construction.
   b. Remain available during construction.
   c. Meet the requirements outlined in Section 1.7.

6. Equipment delivery lead time shall not be held as a valid reason for requesting luminaire substitution unless luminaire lead time from specified manufacturer is in excess of 14 weeks. It shall be sole responsibility of Electrical Contractor to determine necessary equipment lead times, deliver submittals for review in a timely fashion, and place orders accordingly to ensure timely delivery.
7. Electrical Contractor shall guarantee pricing on all luminaire types for which a substitution request has been granted. This price guarantee shall be per unit and shall be maintained through the end of construction, regardless of quantity purchased.

1.6 Warranty

A. LED Luminaires including exit signage: Provide Manufacturer's warranty for a period of not less than five years from the date of final acceptance or the specified warranty period greater than five years for repair or replacement of defective electrical parts, including light source and driver.

B. Luminaires without integral LED sources: Provide manufacturer's warranty for a period of not less than one year from the date of final acceptance including parts and labor for full replacement of defective product.

1.7 SUBMITTALS

A. Refer to Specification 016000 for Comparable Product Request Submittal requirements for manufacturers not listed in luminaire schedule.

B. Submit in four consecutive parts as described below:

1. Part 1 – Construction Luminaire Schedule
2. Part 2 – Product Data
3. Part 3 – Shop Drawings
4. Part 4 – Samples

C. Electronic Submittal Format

1. All submittal materials shall be submitted in electronic PDF format with bookmarks for each luminaire type.
2. Submittals exceeding 200 letter-size pages should be broken into multiple volumes in a logical means each not exceeding 100 pages.
3. Submittals which do not include functional bookmarks or exceed 200 pages are subject to return without review.

D. Construction Luminaire Schedule – Upon award of contract, submit for review a schedule of each type per the Design Luminaire Schedule with manufacturer, base part number, driver type, current contractor-net unit price, and current lead time. A bill of materials only is not acceptable.

1. Do not include installation or miscellaneous electrical hardware costs.
2. Any potential conflicts with lead times, ceiling compatibility, control methodology, etc. should be identified in this submittal.

E. Product Data – Following review of Construction Luminaire Schedule, and in addition to complying with requirements of Section 26 0000 - General Electrical Requirements, submit the following:

1. Resubmit Construction Luminaire Schedule with each Product Data submission highlighting any changes. For partial submittals, indicate the types included.
2. Manufacturer's standard submittal data (cut sheets). Affirm in writing that any date stamps greater than 12 months old have been verified as the most current available.
3. In the event standard cut sheets do not include the following details, submit supplemental pages to include:

   a. Physical characteristics: construction materials, finish type and options, dimensions, weights
   b. Input wattage per unit, per module, or per linear foot as applicable.
   c. LED data:

      1) IES TM-30-18 color rendering data: vector graphics and fidelity, gamut, hue bin 1, and other hue bin values as referenced in Design Luminaire Schedule
      2) Chromaticity tolerance: binning and D_{UV}
      3) IES reported lumen maintenance

   d. Photometric Data Reports: Reports of numerical and graphical data for example product configurations. Note, this is different than IES-formatted electronic photometric data, or IES files.

      1) Coefficients of utilization
      2) Luminance table
      3) Candela distribution data
      4) Zonal lumens
      5) Area and roadway luminaires shall include Iso-candela Charts, IES Roadway Distribution Classification and IES BUG (Backlight-Uplight-Glare) ratings.

F. Shop Drawings – Upon acceptance of product data, submit the following:

1. Installation instructions
2. Component replacement instructions. Note that installing contractor should be prepared to demonstrate for Engineer or Inspector how electrical components are accessed.
3. Parts list for each luminaire accessory
4. Power control gear (drivers, power supplies, transformers) product data indicating dimming range, control type, dimming curve, and wattage rating.

5. Submit documentation that indicates specified products have been tested, or will be tested, for compatibility with the lighting controls being procured and will perform as specified. Control devices or system shall be able to control luminaires with flicker free, continuous dimming, in range specified. Electrical Contractor, luminaire manufacturer, and lighting control manufacturer shall be financially responsible for any incompatibilities.
6. No variation from the general arrangement and details indicated on Contract Documents shall be made on shop drawings except as required by actual conditions. All variations shall be marked on drawings submitted for approval.
7. Site-specific configuration drawings shall include all details required to understand the installation and final appearance of the product to include at minimum:
    a. B-type luminaires: installation base details and dimensioned pole drawings (as applicable) shall be based on contract documents with revisions as required for written approved by the manufacturer and the installing contractor. Pole data shall include wind loading, finish type, locations of hand holes or any remote-mounted power or control devices.
    b. C-type luminaires: shall include full run lengths, mounting points, joints, driver locations, feed points, pre-fabricated corners with dimensions, telescoping ends, non-orthogonal angles, remote driver distance requirements
    c. D-type luminaires: installation and mounting details for applicable ceiling systems or written acceptance by Contractor that standard details provide all necessary information.
    d. F-type luminaires: mounting details, accessory installation
    e. L-type luminaires: dimensioned drawing of each unique run length/wiring configuration, joint details, mounting hardware, end-plates, pre-fabricated corners or intersections, aiming direction for asymmetric luminaires.
    f. P-type luminaires: fully dimensioned drawings for each unique ceiling and height condition indicating canopy dimensions, suspension type and length, suspension field-modification instructions, overall drop
    g. R-type luminaires: installation and mounting details for applicable ceiling systems or written acceptance by Contractor that standard details provide all necessary information.
    h. S-type luminaires: Due to specialty nature of this category, all criteria herein may apply. It is recommended to submit shop drawings for these types separate from other types for multiple iterations which may be required.
    i. T-type luminaires: installation and mounting details for applicable ceiling systems or written acceptance by Contractor that standard details provide all necessary information.
    j. W-type luminaires: installation and mounting details for applicable wall finish systems or written acceptance by Contractor that standard details provide all necessary information.
    k. X-type luminaires: mounting hardware and dimensioned drawings showing mounting each mounting condition (stem, mullion, specialty ceiling, etc.) as applicable.
    l. Site-specific drawings are not required for products which are shipped as fully assembled luminaires exclusive of accessories installed by hand. In lieu of these drawings, written acceptance by Contractor that standard details provide all necessary information is acceptable.

G. Samples:
1. Where noted on Design Luminaire Schedule, submit a working sample for evaluation by Architect/Engineer/Lighting Designer.
2. Where submitted for approval as an unlisted alternate manufacturer, Contractor shall furnish one working sample of each luminaire type proposed. Substitution requests are not permitted after bid.
3. Requirements
    a. Meet all criteria as scheduled for luminaire type. Demo case samples are generally not acceptable.
    b. For linear product types, submit a 4-foot section unless specified to be less than 4-ft in length or as otherwise noted.

c. Submit pre-wired with dimmer or other control gear necessary to demonstrate specification compliance.
d. Samples are not guaranteed to be returned. Approved samples of modified equipment will be retained for the duration of construction as the standard of fabrication.

4. Finish:

a. At request of Architect or Engineer, or where specific finish or color is not specified and options exist, submit color or finish samples to Architect for selection/confirmation.
b. Where finish color is specified, submit all available options which may apply for confirmation. Examples: "white" may be gloss, textured, or matte; "gray" may be graphite, gunmetal, or natural anodized, etc.

5. Accessories: Where noted on Design Luminaire Schedule and in product data review, furnish optical accessories for confirmation.
6. Shipping: Complete samples shall be shipped, prepaid, to Architect/Engineer/Lighting Designer or jobsite, or other agreed upon locations.

1.8 LUMINAIRE MOCK-UP SAMPLES

A. Following review of product data, provide [1] working sample of luminaire type C3, 10 ft in length, as scheduled on sheet E-600 with all control gear required for intended operation pre-wired with quick-connectors or as directed by Contractor.

B. Include all hardware for installation in actual architectural conditions for review by Architect/Engineer/Lighting Designer and Owner. Samples may not be returned.

C. Luminaire approval is not complete without Architect's acceptance of mockup.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Requirements for individual luminaire types are defined on the Design Luminaire Schedule published on drawing sheet E-600 and is part of this specification. Refer to this schedule for application-specific criteria.

B. Provisions for North Carolina General Statute 133-3 requirements:

1. The basis of design and pre-approved alternate manufacturers are listed in the Design Luminaire Schedule to establish the specification criteria. These products may not be identical but have been reviewed to meet the application requirements in respect to performance, aesthetics, and construction and is representative of the specification in regard to these criteria.
2. Where fewer than three manufacturers are known which meet the application requirements, as many as possible are listed to establish the specification.
3. Additional manufacturers may bid provided they can demonstrate compliance with the specified criteria.

C. LED Drivers:

1. Shall be manufacturer recommended compatible driver.
2. All LED drivers shall be dimming type standard unless otherwise noted. Refer to construction documents for control per application.
3. Manufacturers must be compatible with lighting control system(s) provided and control luminaires to specified minimum output per Luminaire Schedule and Sequence of Operations intent.

D. Low Voltage Transformers (aka: power supplies, remote drivers):

1. As approved by luminaire manufacturer

E. LED Modules:

1. Philips Lumileds, Xicato, Cree, GE, Samsung, Nichia, Osram, Sylvania, Bridgelux, Citizen or as specified in the Luminaire Schedule

2.2 FABRICATION AND MANUFACTURE

A. Luminaires

1. Painted after fabrication
2. Finish selection:
   a. The basis of design standard finish is to be submitted where no selection is indicated.
   b. Finishes as identified on Design Luminaire Schedule may refer to standard options for basis of design which may be a premium option for alternate manufacturers.
   c. Where finishes are not determined on Design Luminaire Schedule they are to be selected by Architect from all available standard options.
   d. Finishes indicated on Design Luminaire Schedule as “premium” or “custom” are to be selected by Architect from all available options including those indicated as a cost premium.
3. Luminaires shall bear label indicating circuit voltage. Labels shall be visible by access location but concealed from normal viewing angles.
4. Luminaires shall be constructed with joints made by means of welded, brazed, screwed, or bolted construction methods.
5. Housings shall be so constructed that all electrical components are accessible and replaceable without removing luminaires from their mountings.
6. Surface temperatures of luminaires with integral drivers shall not exceed 90°C in 30°C ambient.
7. Miter cuts shall be accurate, joints shall be flush and without burrs.
8. Luminaires shall be free of light leaks and designed to provide sufficient ventilation of source to provide the photometric performance documented. Low voltage transformers and drivers shall be vented per manufacturer’s specifications.
9. Ceiling construction noted on Design Luminaire Schedule is basis of design for trim and hardware selection. Verify types of ceiling construction with General Contractor prior to releasing luminaires for fabrication and delivery and provide luminaires adapted to ceiling construction used.

B. LED Luminaires are considered a lighting system with dependent components that must be evaluated as a complete system. Each LED luminaire includes a light emitting source, provisions for heat transfer, electrical control, optical control, mechanical support and protection, as well as aesthetic design elements. All LED luminaires shall:

1. Be NRTL 3rd party tested to applicable UL standards. Where remote drivers are specified, all drivers shall also have UL listing or equivalent and comply with code requirements.
2. Be tested to IESNA LM-79-19 testing using absolute photometry criteria.
3. Be reported greater or equal to 70% lumen maintenance at 50,000 hours of operation.
4. Be rapid cycle stress tested.
5. Have integral LED modules with a minimum operating temperature of -20°C.
6. Have modules that are capable of being easily replaced upon failure with a manufacturer provided replacement module without voiding the UL listing of the luminaire.
7. Have drivers with integral surge protection.
8. Have driver housings easily accessible for ease of maintenance.
9. Have a maximum operating temperature at LED junction to not exceed 90°C over the expected operating range of the luminaire.

10. Be RoHS compliant, lead and mercury free.
11. Have an LED operating frequency of + or – 120 Hz.
12. Must meet the appropriate Federal Communications Commission (FCC) requirements for FCC 47 CFR 15 (consumer use) and/or FCC 47 CFR Part 18 (industrial use)
13. Be Class A Sound rated.
14. Be supplied with power supply that complies with IEEE C. 62.41-1991.
15. Operate at 120 or 277 volts, ±10%.
16. Have reverse polarity protected at all hardwired connections and have high voltage protection in the event connections are reversed or shorted during the installation process.

C. Optical controls and accessories:

1. All lenses or louvers shall be removable but secured such that normal motion will not cause them to drop out.
2. All glass used in luminaires shall be made from thermal shock resistant borosilicate glass.
3. Optical lenses shall be free from spherical and chromatic aberrations.
4. Aluminized reflectors and louvers shall be low iridescent equivalent to Coil Anodizers.
5. Luminaires with adjustment beam angle shall be constructed for reliable locking.

D. Finishes

1. Provide luminaires with finish as shown in the luminaire schedule. Verify final finish requirements before releasing luminaires for fabrication.
2. Painted luminaires shall be painted after fabrication or "post painted".
3. Ferrous parts and supports shall be rust proofed after fabrication.
4. For weatherproof or vaportight installations, painted finishes of luminaires and accessories shall be weather resistant using proper primers or galvanized and bonderized epoxy, so that entire assembly is completely corrosion resistant for service intended and rated for an outdoor life expectancy of not less than 20 years.

E. Wiring

1. Luminaires shall be completely wired at the factory and as required by code.
2. Internal wiring shall contain no splices.
3. Connections shall be made with insulated "wire nut" type mechanical connectors except that driver connections shall comply with NEC Article 410.
4. Luminaires shall be provided with flexible conduit, pigtails, and equipment for external connections.
5. Recessed luminaires installed in inaccessible ceilings shall be UL listed for through wiring with the junction box accessible from the luminaire opening.
6. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.
7. Luminaires located in hard, inaccessible, ceilings shall be branch through-wire listed.

F. Ceiling Coordination

1. Verify type of ceiling construction prior to releasing luminaires for fabrication and delivery.
2. Provide mounting appurtenance, flanges, sloped ceiling adaptors where required.
3. Provide mounting assembly, clips or other mechanical mounting lugs as required for support of luminaires.

G. Track-Lighting Systems:

1. Provide lighting track types as specified in Luminaire Schedule, in lengths as indicated on lighting plans.

2. Lighting track system to include current carrying bus for low voltages (12V or 24V). Provisions for line-voltage track are not included as they are not applicable to this project.

    a. Components shall be UL Listed as applicable for low voltage use.
    b. Maintain continuity of conductors through feeds, splice fittings and boxes. Relative positions of current-carrying components must always be maintained along continuous run so that track fittings connect into track in a consistent manner.
    c. Support lighting track at intervals recommended by track manufacturer.
    d. One and two circuit low voltage Lighting Track shall be supplied with three conductors and have the ability to have each circuit separately switched with either magnetic or electronic transformers provided by the track manufacturer. Two circuit low voltage Lighting Track shall be fed from common multi-channel transformers.
    e. All transformers shall be supplied with both primary and secondary voltage over-current protection devices that shall remain readily accessible for maintenance and testing purposes.
    f. Lighting Track shall have the ability to be dimmed or switched in selected sections as indicated on plans in addition to dimming or switching an entire track configuration or track run. Separate, single circuit transformers are required for each independently controlled circuit with the use of electrically isolated couplers.

H. Outdoor Lighting Systems:

1. Provide luminaires, mounting arms, brackets, poles, hand-hole covers, base components, and all other accessories for a complete assembly. Manufacturers shall be responsible for proper fitting of elements and structural integrity of unit
2. Provide poles as shown on luminaire schedule.

    a. Poles shall be aluminum unless otherwise specified on luminaire schedule.
    b. Poles shall have hand-holes.
    c. Fusing for each luminaire head shall be located in hand-hole near base of pole.
    d. Pole base anchor bolts shall be galvanized.
    e. Poles shall be wind-load rated for 130 mph winds in combination with maximum EPA of luminaire head(s).

3. Exterior Luminaires:

    a. Shall operate at a minimum ambient temperature of 0°F.
    b. Shall be fully gasketed, with UL wet location label. A damp location label is acceptable as specified for covered locations.
    c. Shall have wire mesh screens for ventilation openings.

4. All castings and extrusions shall be given minimum one coat of baked-on clear lacquer, unless painted finish is specified.
5. Aluminum surfaces shall receive a duronodic or polyester powder paint finish.
6. Cast-in Luminaire housings installed directly in concrete shall be fabricated of hot dip galvanized steel or cast aluminum or composite.
7. Where cast aluminum housings are used, give two coats of asphaltum paint prior to installation.
8. Provide 1/8” thick x 2” diameter solid neoprene grommets at each point light luminaire surfaces are mounted to concrete structure.

2.3 LED SOURCES

A. Static white LED sources shall be:

1. Minimum CRI of 85 unless noted otherwise on Luminaire Schedule
2. Less than 5% flicker
3. Within 0.004 on the CIE 1976 diagram for color spatial uniformity

4. Within 0.007 on the CIE 1976 diagram for color maintenance over the rated lifetime of the source
5. Binned within a 3-step MacAdam ellipse minimum, or as indicated in Luminaire Schedule
6. Have a published life rating based on the point at which LED sources reach L70 lumen maintenance and tested in accordance with IES LM80-08 Approved Method: Testing Lumen Maintenance of LED light sources and IES TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources
7. LED modules, unless noted otherwise, shall be provided by light fixtures manufacturer installed within the luminaire.
8. Screw-base LED replacement lamps, where required and listed on the luminaire schedule, shall meet dimming, output, CCT and CRI as specified. 25,000 hours is acceptable L70 rated life for these products.

2.4 POWER CONTROL GEAR (DRIVERS, POWER SUPPLIES, TRANSFORMERS)

A. Manufacturer and type as approved by luminaire manufacturer.

B. Must be tested to be compatible with lighting control system(s) provided and control luminaires to specified minimum output per Luminaire Schedule and controls intent documents.

C. Include minimum surge protection of 2 KV for all interior or building-mounted luminaires. Free-standing luminaires shall have surge protection of 10 KV.

D. Construction:

1. Integral to luminaire, replaceable, and accessible through housing unless specified otherwise
2. Class A sound rated
3. Operate system LEDs within the current limit specification of the LED manufacturer.
4. Drivers for use in cold or freezer rooms, parking structures, loading docks, and outdoors shall be low temperature type.
5. Be supplied with over-temperature protection circuitry.
6. Be within a NEMA enclosure.
7. Be equipped with knockouts to accommodate standard conduit sizes
8. Equipped with resetting thermal sensitive device.
9. Meet or exceed all ANSI or NEMA standards

E. Performance:

1. Operate at 60 Hz and voltage as scheduled.
2. ETL certified, CBM and UL Listed, high power factor, and meet or exceed NEMA and ANSI Standards.
3. Capable of operating LEDs with less than 5% flicker
4. Dimming protocol as noted on Design Luminaire Schedule.
5. Be programmable on-site to allow for LED replacement modules to be “tuned” to match the output of remaining adjacent modules in the event that there is noticeable lumen depreciation.
6. Have a Power Factor = or > than 0.9
7. Be DMX compatible in Color changing or tunable LED luminaires.

F. LED Data Enablers shall be:

1. Compatible with DMX
2. NEMA-rated enclosure
3. Equipped with knockouts to accommodate standard conduit sizes
4. Convection cooled
5. RoHS compliant

G. Low-Voltage Transformers:

1. Sized to compensate for voltage drop over indicated distances
2. Locally fused
3. Line voltage disconnecting means within reach.
4. Provide adequate ventilation to meet code and manufacturers requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Marking:

1. Voltage identification: Luminaires designed for voltages other than 110-125 volt circuits shall be clearly marked with rated voltage.
2. Markings must be clear and shall be located to be readily visible to service personnel but invisible from normal viewing angles when luminaires are in place.

B. Installation of Luminaires:

1. Housing, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
2. Install decorative luminaires, reflector cones, baffles, aperture plates, lenses, trims, and decorative elements of recessed luminaires after completion of ceiling tile, plastering, painting, and general cleanup is completed. Where luminaire location or construction does not permit sequential installation, all reflectors, lenses, flanges and other visible surfaces shall be carefully protected.
3. Verify primary orientation of direction luminaires with drawings and manufacturer instructions prior to installation to include wall washers, cove lights, floodlights, exterior area lights other than Type V, and adjustable accent luminaires.
4. Light leaks between ceiling trim of recessed luminaires and ceiling are not allowed.
5. Locations:

   a. Install luminaires at locations and heights as indicated.
   b. Do not scale electrical drawings for locations of luminaires.
   c. Architectural reflected ceiling plans and elevations show locations of luminaires.
   d. Where noted on the drawings, the exact location of luminaires shall be confirmed (in the field) with the Architect/Engineer prior to installation.
   e. Mount all luminaires so as to maintain full range of motion.
   f. Install luminaires plumb, square, and level with ceilings and walls.
   g. Coordinate stem, rod, chain, or aircraft cable hanger lengths with job conditions. Provide extra length of adjustable supports where diffusers are mounted directly above light fixtures to facilitate air balancing efforts.
   h. Industrial type luminaires in unfinished areas, which are near obstructions such as ducts and pipes, shall be:

      1) Suspended so that bottom of luminaire is no higher than bottom of obstruction
      2) Located at height of lowest luminaire
      3) Minimum height: 8’-0”
      4) Shall not be located until locations of obstructions are determined.
      5) Where a minimum height of 8’-0” is unachievable, wall mounted luminaires will be utilized.

6. First-in-place Mock-up: Where luminaires are to be concealed in highly visible public spaces or coordinated with premium finishes, a small sampling of luminaires shall be installed, adjusted, temporarily energized, and aimed for Architect/Engineer's approval, prior to installing remaining luminaires of same type.

7. Support

   a. Support surface mount luminaires from building structure.
   b. Metal decking shall not be pierced for luminaire support.
   c. Provide luminaires and/or luminaire outlet boxes with hangers to support luminaire weight.
   d. Troffers shall be held in place by support clips.
   e. Provide plaster frames for recessed luminaires in plaster ceilings.
   f. Rigid metallic pipe stems shall be utilized for the support of pendant mounted luminaires, unless otherwise noted.
   g. Stem hangers shall be equipped with aligner box covers or canopies so that stems hang vertically, irrespective of the angle of the surface they are mounted from.
   h. Wherever a luminaire or its hanger canopy is attached to a surface mounted outlet box, a finishing ring shall conceal the outlet box.
   i. Yokes, brackets and supplementary supporting members needed to mount luminaires to suitable ceiling members shall be furnished and installed by Contractor. Verify mounting hardware required prior to installation.
   j. Recessed luminaires shall be supported with 12 ga wire hangers, 2 per luminaire, at diagonally opposite corners.
   k. Troffers and luminaires over 55-lbs, such as 4x4s shall be supported with 12 ga wire hangers, 4 per luminaire, 2 at 45-degree diagonals, and two perpendicular to structure. Wire hangers and attachment to structure shall be capable of supporting 4 times luminaires weight.
   l. In areas with seismic requirements, suspended or pendant mounted luminaires shall be able to swing 45 degrees in any direction without hitting an obstruction. In the event hitting an obstruction is unavoidable, guy wires will be used to secure the luminaire in place.
   m. Surface luminaires installed in grid ceilings shall be supported by independent support clips and 12 ga wire.
   n. Exit signs installed in grid ceilings shall be supported by electrical box hanger and additional 12 ga wire installed from box to structure.
   o. Support surface mounted luminaires greater than 2-ft in length at a minimum of each additional 2-ft, or as recommended by manufacturer.
   p. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.
   q. Rigidly align continuous rows of luminaires.
   r. Luminaire types with remote mounted driver shall have:

      1) Proper support for driver weight.
      2) Mounting distance from remote driver to luminaire per manufacturer's recommendations.

8. Mounting and Enclosures

   a. Install flush mounted luminaires to eliminate light leakage.
   b. For luminaires mounted adjacent to insulation, provide barrier to prevent insulation from coming in contact with luminaire, unless luminaire is approved for installation in contact with such insulation.
   c. Provide approved fire rated enclosures around luminaires in fire rated ceilings.

9. Conduit and Wiring

   a. Wire for connections to modules and auxiliaries shall be suitable for temperature, current, and voltage conditions.
   b. Recessed luminaires shall have final connections made with flexible metal conduit, not in excess of 6-ft (72”), with THHN conductors and green wire ground conductor.

c. Conduit shall be hidden from normal view in all possible cases. In public areas where surface mounted conduit must be used, contractor shall install conduit as unobtrusively as possible. Contractor shall obtain field approval by the architect for all exposed conduit runs prior to rough in.

10. In-Grade Luminaires:

a. Where installed in tree grates, furnish burial light lens and louver to tree grate manufacturer for coordination of opening.
b. Provide adequate drainage system per manufacturer's recommendations.

C. Installation of Outdoor Pole Bases

1. Contractor shall provide bases for luminaires.
2. Provide handhole for electrical connection within 4’-0” of pole base.
3. Contractor shall:

a. Rough-in conduits
b. Coordinate spacing, base dimensions, heights, orientation of bases, etc. as necessary.

4. Where square or rectangular poles or luminaire heads are used, Contractor shall verify orientation with Architect/Engineer/Lighting Designer.

D. Pole Installation:

1. Install luminaires, poles, hardware, etc., for complete system.
2. Use web fabric slings (not chain or cable) to raise and set poles.

E. Grounding:

1. Ground luminaires and metal poles according to Division 26 Section "Grounding and Bonding for Electrical Systems".
2. Poles:

a. Install 3m (10 ft) driven ground rod at each pole.

3. Nonmetallic Poles:

a. Ground metallic components of lighting unit and foundations. Connect luminaires to grounding system with #10 AWG conductor.

3.2 AIM AND FOCUS WALK THROUGH

A. Contractor shall provide electrician's services to aim, adjust, and focus luminaires with adjustable mechanisms and optical accessories at direction of Architect/Engineer/Lighting Designer.

B. Scheduling: Contractor shall include aim-and-focus process in regular construction activities schedule.

1. Aim-and-focus process cannot be completed until all luminaires are installed and energized and all finishes are installed.
2. Room finishes, signage, landscape planting, etc. must be in-place at time of aim-and-focus visit.
3. Architect/Engineer/Lighting Designer shall be available for one daytime and one nighttime site visit for a duration not to exceed 6 consecutive hours each.
4. Rescheduling due to lack of readiness by the contractor shall be at the Architect/Engineer/Lighting Designer’s discretion. Any delays or cost-impacts due to a lack of preparedness once designer is routed to the jobsite shall be the responsibility of the contractor.

C. Contractor shall provide equipment necessary to access luminaires including ladders and mechanical lifting systems. Where scaffolding is required to install luminaires, aiming should take place before scaffolding is deconstructed.

D. Contractor shall provide all tools required to access optical accessories for adjustment purposes.

E. Contractor shall provide all spare optical accessories specified (or as noted in submittals) to be labeled to conform to approved product data. Note that manufacturer accessory ordering nomenclature for items shipped loose rarely coincides with fixture ordering matrix. All items need to be identified to replicate conditions.

F. Where multiple installations exist, the Architect/Engineer/Lighting Designer may direct one instance as an example for the Contractor to execute throughout.

G. Additional provisions for S1, S1A systems to be accomplished prior to aim-and-focus walk-through.

1. Install two linear lighted modules of S1 and S1A system on “circuit 1” to be evenly spaced within the channel and aligned with nearby luminaires.
2. Install spot/flood modules on “circuit 2” between linear components, two for S1 and four for S1A.
3. Install blank sections between lighted modules for consistent appearance.
4. Additional time following beneficial occupancy may be required to aim and focus luminaires according to Owner-furnished artifacts and furnishings.
5. Secure all spare components in original packaging to be readily available (e.g. in nearby electrical room) when aiming activities take place and turn over at closeout.

3.3 QUALITY CONTROL

A. Protection wrapping luminaires shall be removed before installation of furniture, but after finish work is complete.

B. Prior to final punch, replace LED modules/LED luminaires which are not operating properly.

C. Deliver spare equipment to Owner’s representative.

D. Adjusting and Cleaning:

1. Clean luminaires of handling marks, dust, and dirt. in accordance with luminaire manufacturer's recommendations.
2. All trims, lenses, joints, and accessories shall be installed secure without gaps or light leaks.
3. Damaged luminaires or components shall be replaced with new.
4. Keep luminaires clean and protected for remainder of construction period.
5. Check that all luminaires subject to aim-and-focus walk through have been adjusted to the Architect/Lighting Designer’s direction and reset any luminaires which have been adjusted out of position by construction activities.
6. Check settings of sensors integral to luminaires are consistent with direction from the Architect/Engineer
7. All finishes which have been damaged are to be repaired per manufacturer direction to match factory color.

3.4 CLOSE-OUT

A. Contractor shall provide Owner with one (1) complete hardcopy and one (1) digital copy of Operations and Maintenance manuals.

1. All “Approved as Noted” comments shall be addressed in this record manual set.
2. Each manual shall contain at a minimum:

a. Detailed as-built shop drawings for all lighting equipment installed.
b. Manufacturer’s product cut sheets for all equipment installed keyed by type to as-built drawings with all part number nomenclature defined and highlighted.
c. Manufacturer’s complete installation instructions for all equipment installed keyed by type to as-built drawings.
d. Equipment maintenance requirements and schedules.
e. Equipment manufacturer contacts.
f. Equipment manufacturer warranties for luminaires, drivers, and LED modules.

B. Contractor shall provide qualified personnel onsite to provide a minimum of one day of training to Owner's representatives.

C. Owner training shall cover:

1. Luminaire use including deviations from standard installation drawings
2. Luminaire maintenance including access to components mounted in inaccessible ceilings.
3. Manufacturers’ recommended cleaning methods and schedules
4. Components common to multiple luminaire types and components of similar luminaires which are not compatible.
5. All other features of luminaires germane to the maintenance of the lighting systems.

END OF SECTION 265000

SECTION 270000 - GENERAL COMMUNICATIONS 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 SCOPE

A. Work under this section shall include providing all labor, materials, equipment, and services necessary for and reasonably incidental to the proper completion of all Network communications work as shown on the drawings and herein specified. Work shall also include, but not be limited to the furnishings, unloading, handling, distribution, setting, supporting, and installation of all required components.

B. Contractor to install a complete turn-key telecommunications system. Coordinate with UNCW ITS prior to install to review systems layout of plans and new telecom room.

C. Installation of all systems and materials shall be accomplished in accordance with the UNCW ITS Communications Guidelines.

1.3 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations, or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

F. Refer to the Technology drawings which include:

1. Equipment room, Telecom room (TR) and station outlet location.
2. Outlet elevation: showing all components required for the installation and mounting of the outlet. The faceplate of a typical quad station outlet and all outlet configurations used.
3. Outlet pathway elevation: shows the details of how the cables routing from the horizontal pathway to the outlet. Conduit size is at a minimum ¾ inch stubbed out to within six inches of the cable tray and bonded to the cable tray. In a typical cable tray, voice and data will be located on one side of the cable with the A/V cabling located on the opposite side.

4. Grounding and bonding drawing: Shows the five major components for the grounding of the Network communications infrastructure throughout the building. The five components shown are the Bonding conductor, the Network communications main grounding bus bar, the Network communications grounding bus bar, the Network communications bonding backbone, Network communications bonding backbone interconnecting bonding conductor. All grounding and bonding shall meet the TIA/EIA -607 standards and the NEC code.
5. Campus Wide Drawings: Show all details for each individual campus wide access door interior and exterior. Drawings are not to scale. Refer to architectural and structural drawings for building construction and dimensions and to roof finish schedule on architectural drawings for the materials, finish and construction method of walls, floor and ceiling in order to insure proper rough in and installation of work.

G. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

H. Where architectural features govern location of work, refer to architectural drawings.

I. All work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.4 RELATED WORK

A. Related Division 27 Sections include:

1. Section 270526 - Grounding and Bonding for Communications Systems
2. Section 270528.29 - Hangers and Supports for Communications Systems
3. Section 270528.33 - Raceway and Boxes for Communications Systems
4. Section 270528.36 - Cable Tray for Communications Systems
5. Section 270553 – Communications Systems Identification
6. Section 271000 - Structured Cabling
7. Section 271100 - Communications Equipment Room Fittings
8. Section 271300 - Communications Backbone Cabling
9. Section 271500 - Communications Horizontal Cabling

B. Continuity of Service:

1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
2. When interruption of services is required, persons concerned shall be notified and shall agree upon a time.

C. Concrete Work:

1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
2. Concrete shall comply with Division 3 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.

D. Painting:

1. Furnish equipment with factory applied prime finish unless otherwise specified.
2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.
3. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.
4. Contractor is responsible for installing and painting plywood in new Telecommunications Rooms.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State, and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.6 CONTRACTOR REQUIREMENTS

A. All cable installation and components / connections / terminations / etc., shall be installed and certified as a complete "end-to-end" cabling solution from the manufacturer.

B. All installations shall be by factory certified / authorized and qualified technicians for products for which they are working with. Factory certified personal shall include a minimum of 25% (twenty-five percent) having achieved the highest level of certification offered by the factory and a total of 80% (eighty percent) shall hold at least the minimum certification offered by the factory. Absolutely no more than 20% (twenty percent) of the workers that shall be handling, working with, or otherwise involved with any aspect of telecommunication cabling shall be unskilled labor.

C. BICSI technician level certification is also required. BICSI certification is the preferred route and 15% (fifteen percent) of work force shall be BICSI certified 'Technician level or better (RCDD). 15% (fifteen percent) of work force shall be BICSI certified Installer level 2 or higher; 15% (fifteen percent) of work force shall be BICSI certified installer level 1 or of equivalent experience/training. Absolutely no more than 20% (twenty percent) of the workers that shall be handling, working with, or otherwise involved with any aspect of telecommunication cabling shall be unskilled labor.

D. The Contractor of Record shall submit all communications materials for review and approval by the Designer of Record and UNCW ITS prior to any procurement as described in the Submittals sections of this document. Items of telecommunications electronic equipment are typically purchased and installed by the Owner. The Contractor of Record shall refer to the project bid document and the construction contract documents for all details of scope and responsibility.

E. The Contractor of Record is responsible for all testing. See "Execution>Testing and Acceptance" of this section for full requirements.

F. The Contractor of Record is responsible for ensuring proper coordination across subcontract trades. In particular, coordination between electrical subcontractors and telecommunications subcontractors is critical. For example, in some cases bonding systems and conduit systems may be installed either by the electrical or telecommunications contractor. Both must be kept abreast of the specifications and contract requirements.

1.7 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:

1. ANSI/NFPA 70, National Electrical Code
2. ANSI/NETA ATA, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
3. ANSI/NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling
4. UNCW ITS Communications and Infrastructure Guidelines
5. BICSI, Telecommunications Distribution Methods Manual, 12th Edition.
6. Local Electrical Code.
7. STS-1000 Telecommunications Wiring Guidelines.
8. ISO/IEC 11801, Information technology – Generic cabling for customer premises
9. Telecommunications Industry Association, TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises

10. Telecommunications Industry Association, TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
11. Telecommunications Industry Association, TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
12. Telecommunications Industry Association, TIA-568-C.3, Optical Fiber Cabling Components Standard
13. Communications Infrastructure Guidelines page 5
14. Telecommunications Industry Association, TIA-568-C.4, Broadband Coaxial Cabling and Components Standard
15. Telecommunications Industry Association, TIA-569-D, Telecommunications Pathways and Spaces
16. Telecommunications Industry Association, TIA-598-C, Optical Fiber Cable Color Coding
17. Telecommunications Industry Association, TIA-606-B, Administration Standard for Telecommunications Infrastructure
18. Telecommunications Industry Association, TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
19. Telecommunications Industry Association, TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
20. Country, state and local health, safety and building codes
21. UL 444, Communications Cables
22. UL 969, Marking and Labeling Systems

B. Agencies or publications referenced herein refer to the following:

1.	ANSI	American National Standards Institute
2.	ASME	American Society of Mechanical Engineers
3.	ASTM	American Society for Testing and Materials
4.	BICSI	Building Industry Consulting Services International
5.	BICSI CO-OSP	Customer-owned Outside Plant Design Manual
6.	EIA	Electronic Industries Alliance
7.	FIPS	Federal Information Processing Standards
8.	FCC	Federal Communications Commission
9.	ICEA	Insulated Cable Engineers Association
10.	IEEE	Institute of Electrical and Electronics Engineers
11.	NEC	National Electrical Code
12.	NECA	National Electrical Contractors Association
13.	NEMA	National Electrical Manufacturers Association
14.	NESC	National Electrical Safety Code
15.	NETA	National Electrical Testing Association
16.	NFPA	National Fire Protection Association
17.	NIST	National Institute of Standards and Technology
18.	OSHA	Occupational Safety and Health Administration
19.	TIA	Telecommunications Industry Association
20.	UL	Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

D. Work to conform with any city, State law, regulation, code, ordnance, and ruling or Fire Underwriters requirement applicable to this class of work.

E. Contractor will comply with the stricter requirement when a conflict occurs.

1.8 DEFINITIONS

A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.

B. Bonding Conductor for Telecommunications (BCT): A conductor that interconnects the telecommunications bonding system to the main electrical service (power) grounding system.

C. Intermediate Distribution Frame (IDF): A room in a building that houses telecommunications equipment (voice, data, security and patient monitoring) for distribution of signals serving the specific floor room is installed on. IDFs should not have lay in ceilings installed. Only equipment, piping, conduit serving the IDF directly are to pass thru or enter the room.

D. Main Distribution Frame (MDF): The primary room in a building in which active telecommunications equipment is located. Typically, this equipment provides service to IDFs and EIDF's located on other floors. MDFs should have lay in ceilings installed. Only equipment, piping, conduit serving the MDF directly are to pass thru or enter the room.

E. Extended Intermediate Distribution Frame (EIDF): A space in a building that houses any of the following: Nurse Call, Paging, Fire Alarm, BAS, DAS. No data, voice or security connections are to be housed/stored or installed in the EIDF. EIDFs should not have lay in ceilings installed. Only equipment, piping, conduit serving the EIDF directly are to pass thru or enter the room.

F. Faceplate: A frame into which communication inserts, blanks, and jacks are secured in support of voice, data, and video services.

G. Floor Boxes: Opening in floor intended to provide electrical and communications service for a conference table or workstation.

H. Grounding Equalizer (GE): A conductor that interconnects two of more TBBs within a multistory building.

I. Patch Panel: Passive communications hardware utilized to terminate voice, data, security and signaling cable with the purpose of identification and patching. Most often used to patch passive cabling to active components, patch panels may be mounted in equipment racks or be wall-mounted.

J. Poke Through: Conduit sleeve through floor providing pathway for communications services typically utilized to serve conference rooms or modular furniture.

K. Power Pole: Vertical metallic raceway with a dedicated channel for electrical service and communications cabling typically utilized to extend electrical and communications service to modular furniture situated in open floor areas with no wall nearby to provide chase for cabling.

L. Static Load: In cable tray systems, the weight of the empty installed cable tray system together with the weight of the installed cables.

M. Telecommunications Bonding Backbone (TBB): A BCT that bonds all TGBs in a building back to the TMGB in the MDF. Typically, 6 AWG or larger.

N. Telecommunications Grounding Busbar (TGB): The primary electrical grounding point in an IDF and EIDF.

O. Telecommunications Main Grounding Busbar (TMGB): The primary electrical grounding connection point in a building for telecommunications services. The TMGB is located in the MDF and connects to the main building service equipment ground.

P. Termination Block: Passive communications hardware utilized to terminate voice, data, security and signaling cables with the purpose of identification and cross connection. Typically wall mounted and most often used to cross-connect voice circuits

1.9 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. AFF Above Finished Floor
2. ATM Asynchronous Transfer Mode
3. AWG American Wire Gauge
4. BAS Building Automation Systems
5. BTU British Thermal Unit
6. CATV Community Antenna Television
7. CCTV Closed-Circuit Television
8. CDDI Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
9. cm centimeters
10. °C degrees Celsius
11. °F degrees Fahrenheit
12. DTMF Dual Tone Multi Frequency
13. EIA Electronic Industries Alliance
14. EF Entrance Facility
15. ER Entrance Room
16. EIDF Equipment Intermediate Distribution Facility
17. FDDI Fiber Distributed Data Interface
18. ft feet
19. GbE Gigabit Ethernet
20. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
21. ID Inside Diameter
22. in inch
23. IPT IP Telephony
24. kg kilogram
25. lbs pounds
26. LAN Local Area Network
27. MC Main Cross-connect
28. m meters
29. mm millimeters
30. Mbps Megabits per second
31. µm micrometer (10-6 meter)
32. OD Outside Diameter
33. PBX Private Branch Exchange (Telephone Switch)
34. pF pico-Farad (10-12 Farad)
35. PVC Polyvinyl Chloride
36. RU Rack Unit
37. sq ft square feet (area)
38. TP-PMD Twisted Pair Physical Layer Medium
39. WAN Wide Area Network
40. WLAN Wireless Local Area Network
41. VoIP Voice over Internet Protocol

1.10 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 1 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 1. However, expression "Shop Drawings" is generally used throughout specification.

3. Mark catalog sheets and drawings to indicate specific items submitted.
   a. Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
   b. Where sheet includes multiple product options, mark proposed option(s).
   c. Where proposed product is not clearly marked entire submittal will be returned rejected without any further review.
4. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
5. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals clearly accordingly.
6. Group submittals by Section to include complete documentation of related systems, products, and accessories. Where applicable, dimensions shall be marked in units to match those specified.
7. Provide submittals of the technician's qualifications include factory training and BICSI certification of all technicians who will be on site.
8. Submittals shall be in electronic form or on paper per Division 1.
   a. Documents in electronic form shall be Adobe Acrobat PDF.
   b. Paper documents shall be original catalog sheets or photocopies thereof.
   c. Facsimile (fax) sheets will not be accepted.
9. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
10. When equipment and items specified include accessories, parts, and additional items under one designation, submittals shall be complete and include required components.
11. Include wiring diagrams for electrically powered or controlled equipment.
12. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories, and clearance for maintenance.
13. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
14. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
15. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
16. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 27 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications and/or electrical raceway layouts.
    a. Unless specifically requested in Division 27 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:
   1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Close Out Submittals (Record Documents and Operation and Maintenance Manuals):
   1. Upon completion of work but before final acceptance of system, submit to Architect for approval, after securing approval, submit 1 electronic copy to Owner.
   2. Manuals shall be in electronic format and organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
   3. Manuals shall include the following:
      a. Copies of shop drawings.

b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
c. Phone numbers and addresses of local parts suppliers and service companies.
d. Internet/WEB page addresses where applicable.
e. Wiring diagrams.
f. Start up and shut down procedure.
g. Factory and field test records.
h. Additional information, diagrams or explanations as designated under respective equipment or systems specification section.
i. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
j. O&M manuals and instructions to Owner shall be provided prior to request for final payment.

1.11 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:

1. Refer to General Conditions of Contract, and Division 1 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged, to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair, or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:

1. Refer to Division 1 - Closeout Procedures.
2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.12 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

1.13 GUARANTEE

A. Refer to Division 1 for general Guarantee (Warranty) requirements.

B. Refer to technical sections for Guarantee requirement for each system.

1. Where no guarantee requirements are called out, guarantee for three years after acceptance by Owner equipment, materials, and workmanship to be free from defect.
2. Materials shall have a minimum of 25-year warranty after acceptance by owner.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Manufacturer must be regularly engaged in the manufacture of unshielded twisted pair, coaxial cables, fiber optics, connectors, hardware, and related systems.

B. All cable installation and components / connections / terminations / etc., shall be installed and certified as a complete "turn-key" cabling solution by the contractor.

C. All structured cabling shall be provided by one of the three end-to-end providers listed in 271000.

D. A complete cabling solution shall be a minimum of, but not limited to, patch panels/connecting blocks/termination panels, cabling, faceplate, jack/plug.

E. Any cable / system listed / advertised / submitted as a Category 6/6A solution shall be warranted by the manufacturer to meet minimum standards published by EIA/TIA standard for Category 6/6A cabling.

F. Testing shall be preformed to validate true Category 6/6A performance and shall be submitted as part of this contract

G. Contractor shall provide a minimum Twenty (20) year cabling Extended Product Warranty and Application Assurance. The warranty will support any performance claims the manufacturer makes over and above the Category 6/6A standards stated herein. A Warranty statement from the Manufacturer stating the period of the warranty for all the products specified for the project and the name and address of the authorized manufacturers agent who will honor the warranty claims.

H. The Extended Product Warranty will cover product defects for all passive manufactured channel components. Passive components are those exhibiting no gain or contributing no energy. Manufacturer warrants, from the date a Registration Certificate passes to the end-user, the following:

1. That the passive products that comprise the registered Channel solution will be free from manufacturing defects in material or workmanship under normal and proper use;
2. That all channel approved passive cabling products that comprise the registered channel solution exceed the specification of TIA 568 and exceed ISO/IEC 11801 standards and will be equal to or exceed to the performance specifications of the associated Communication product data sheet in effect at the time the Registration Certificate is issued;
3. That the installation will exceed the insertion and return loss, attenuation and near end cross talk (NEXT) requirements of TIA 568-B and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards.
4. That each channel is comprised exclusively of a single manufacturer solution and is capable of delivering 1.2 Gbps (Cat 5e), 3.6 Gbps (Cat 6) or 10 Gbps (Cat 6A) to the workstations or WAPs in accordance with applications standards.

5. This extended Product Warranty is applicable to the channel cabling solution products only on the original site of installation. Under the Extended Product Warranty, Manufacturer will either repair or replace the defective product itself at Manufacturers' cost. The U.S.A., Manufacturer will pay an Authorized cable installation Reseller for the cost of labor to repair or replace any such defective product on behalf of Manufacturer.
6. Corning Cable Systems LANscape solutions "landscape extended warranty" a 25-year guarantee on complete fiber optic cabling solutions. The telecom contractor shall be an authorized Corning Cabling Systems extended warranty (NPI) installer.

I. Application Assurance covers failure of the channel SCS to operate the applications, that the Solution is to support, as well as additional application(s) included in the numbered list. Manufacturer warrants that the registered channel SCS solution will be free from failures which prevent operation of the specific applications for which the original channel SCS was designed. The Application Assurance Program also covers the following additional applications:

1. Those identified in the current (at the time of installation) channel SCS Performance Specifications; and
2. In accordance with application standards specifications, any applications introduced in the future by recognized standards or user forums that use TIA/EIA 568 or ISO/IEC 11801 components and link/channel specifications for cabling.
3. The contractor's certifications are current for the manufacturer's solution installation. The contractor shall provide standards compliant, warranted, end-to-end channel solution for structured cabling solutions.

J. Contractor shall state any additional Contractor supplied warranty. This contractor warrants the Network communications cabling infrastructure system to be free of defects in the materials and workmanship for the period of one year after the date of final payment. The effective date of this warranty applies to all components of these systems regardless of any equipment manufacturer’s warranties, which may expire at an earlier date. Any system malfunctions or any previously undiscovered non- compliance with the plans and specifications during the warranty period are repaired at no cost to the Owner are brought into compliance.

K. Self-Install Warranty: The beyond cat 6 structured cabling manufacturers shall issue The University of North Carolina at Wilmington a Self-Install Warranty for all future moves, adds and changes that are warrantied under this contract document ‘Extended product warranty and application assurance program for an end-to – end channel solution’.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Store and protect products under provisions of Division 1

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.3 INSPECTION

A. The Project Manager and/or the SCS System Manager shall perform on-going inspections during construction. All work performed is in a high-quality manner. In addition, the overall appearance shall be clean, neat and orderly. The following items need to meet compliance:

1. Cables properly labeled from end-to-end
2. Terminated cables properly tested in accordance with the specifications. Testing includes for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage
3. Cable type suitable for its pathway.
4. Cables bundled in parallel
5. Manufacturer's pathway Guidelines are used. Cable penetrations installed properly and fire stopped according to code
6. Avoid excessive cable bending
7. The potential for EMI and RFI sources considered
8. Correct cable Fill Ratio
9. Hanging supports within 1.5 meters (5 feet)
10. Hanging cable exhibiting sag
11. Network communications room terminations compatible with applications equipment
12. Patch Panel instructions followed
13. Jacket removal point.
14. Termination positions
15. All pair terminations tight with minimal pair distortions.
16. Twists maintained up to Index Strip.
17. Modular Panel instructions followed
18. Cable dressing
19. Jackets remain up to the Connecting Block
20. All pair terminations tight and undistorted
21. Twists maintained up to the Connecting Block
22. Connectors are correct side- up in the Jack Panels without cables wrapped or twisted around the Mounting Collars.
23. Correct outlet connectors used (T568B)
24. Jacket maintained right up to the manufacturer specifications
25. Identification markings uniform, permanent and readable

3.4 DAMAGES

A. The contractor is responsible for all damages to portions of the building caused by it, its employees or subcontractors including but not limited to the following:

1. All damage to any [portion of the building caused by the movement of tools, materials or equipment.
2. All damage to any component of the construction of spaces "turned over" to the contractor.
3. All damage to the electrical distribution system and/or other space "turned over" to the contractor.
4. All damage to the electrical, mechanical and/or life safety or other systems caused by inappropriate operation or connections made by the Contractor or other actions of Contractor.
5. Other damage to the materials, tools and/or equipment of UNCW, its consultants, General Contractor, subcontractors, Architect, other contractors, agents and leases.

3.5 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Firestopping

1. Standard conduit penetrations shall be utilized first and sealed accordingly. Reusable fittings/pathways as described above shall be reserved for owner use/additions/renovations after owner takes position of facility.
2. Furnish and install all fire rated wiring devices and associated hardware as shown on the Contract Drawings and as hereinafter specified.
3. All devices shall be heavy-duty specification grade with an in tumescent insert material allowing for 0 to 100-percent visual fill of conductors.
4. The same manufacturer shall supply all furnished fire rated devices and associated hardware.
5. Fire rated wiring devices shall bear the UL Classification marking.
6. Device testing in accordance with ASTM E 814 (ANSI/UL1479).

G. Fire Rated Wiring Devices

1. Cables passing through fire-rated floors or walls shall pass through fire-rated wiring devices which contain an intumescent insert material that adjusts automatically to cable additions or subtractions.
2. The device shall have an F Rating equal to the rating of the barrier in which the device installation is applied.
3. Wiring devices shall be capable of allowing a 0 to 100-percent visual fill of cables.
4. Wire devices shall be of a sufficient size to accommodate the quantity and size of data cables required.
5. Wire devices provided with steel wall plates for single or multiple devices allowing them for joined.
6. Manufacturers' accepted for fire rated devices include Specified Technologies INC., Hilti, and 3M.
7. Wiring device installation is in locations where drawings indicate on the blue print, and are arranged singly or ganged at the height specified.
8. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
9. Apply the factory supplied gasketing material prior to the installation of the wall plates.
10. Secure wall plates to devices per the equipment manufacturer's recommendations.
11. Buildings at UNC-W wiring is according to the established campus -wide wiring standards since the early 1990's. The fire safety considerations of the pathway systems shall comply with all applicable fire safety and electrical codes. In general, the N.C. Department of Insurance determines the compliance of these systems with codes, and reserves the right to inspect and approve/disapprove their installation. If the pathway system is a metallic, enclosed system non-plenum cabling installation within unless otherwise noted. All wireway and conduit penetrations of rated walls and floors shall be fire stopped per applicable UL assembly. Plenum cable installed as required per the guidelines on an individual building basis. UNC-W adheres to the BICSI, NEC, and ANSI/TIA/EIA-569-A guidelines for fire stopping.

H. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

I. Openings for penetrations shall be minimum 1/2" larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

J. Seal non- fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

K. Seal non-rated wall openings with urethane caulk if listed compatible with associated sleeves and cables.

L. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers, and nuts.

M. Finish and trim penetrations as shown on details and as specified hereinafter.

N. Provide chrome or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

O. In other areas, penetrations shall be sealed.

1. Provide gasketed device cover plates with an additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling, or floor surface.
2. Once wiring is installed, surround wiring with 1" barrier of silicone caulking around conductors within device box hub.
3. Caulk shall be resistant to microbiological growth.

3.6 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair, or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 8 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases, or above inaccessible ceilings.

D. Provide necessary coordination and information to Trade Contractor under Division 8 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions, without limitations.

E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases, or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.

F. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted

3.7 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide, or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.8 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.9 ACCEPTANCE TESTING

A. The Designer of Record shall create a testing and acceptance plan for each communications infrastructure component as a part of the design phase. UNCW ITS must approve the testing and acceptance plan before any installation work can commence. The test plan submittal shall include a sample of testing documentation and proposed test equipment.

B. The Contractor of Record shall conduct all testing and document results. The Contractor of record shall supply all personnel, materials, and equipment required to conduct testing.

C. Contractor of Record shall notify UNCW ITS through UNCW Facilities Planning and Construction a minimum of twenty-one (21) work days in advance of any testing to be performed with details about the specific location of the test and functions to be testing. UNCW ITS may be present for none, any, or all tests performed.

D. At the request of UNCW ITS, the Contractor of Record will re-test any component that UNCW ITS deems not acceptable by virtue of the component in question failing the prescribed test or for which the testing methodology is in question. UNCW ITS must be present for any re-testing that it requests. All personnel, materials, and equipment required for re-testing shall be provided by the Contractor of Record without additional cost to the University. UNCW ITS reserves the right to independently perform its own testing of materials and systems.

E. Test procedures shall confirm that each specification statement has been met or exceeded. The Contractor of Record shall provide an actual demonstration of each system requirement. All tests are subject to validation by means of a re-test, by Contractor, in the presence of the Owner's Representative.

F. Owner reserves the right to reject any component, work, or system that does not comply with the specifications described herein.

G. These are general test criteria that apply to all testing and acceptance activities. Testing criteria for specific components are defined in their respective sections in this document. Note that some wiring components are best tested as a system. Details on this type of testing can be found in CIG02 – Testing and Acceptance of Cabling Systems.

H. Copper Category 6 and/or 6A channels shall be tested as appropriate, with only PASS values accepted, using a TIA-568-compliant Category 6 Time-Domain Reflectometer. Copper Category 6A channels shall be tested, with only PASS values accepted, using a TIA-568-compliant Augmented Category 6 (Category 6A) Time-Domain Reflectometer.

I. Horizontal Cable Testing: Channel testing: Each equipment Network communications room patch cord, patch panel, horizontal cable, RJ 45 jack, Station patch cord will be tested end- to- end for compliance with category 6 level III parameters as stated in the TIA- 568 family of standards. Only certified cat 6-cable testing allowed on each all beyond cat 6 cables. The Test equipment used for horizontal category six cable tests complies with the industry standard Category 6 cable testers level III and comply with TIA test procedures. Each link shall be tested to TIA-568-B pinout, with only PASS results accepted. The contractor, at no charge to UNCW, shall bring any pairs not meeting the requirements of the standard into compliance and complete end-to-end test results documentation to UNCW. The test results will require 2-cd copies.

J. Fiber Optic Testing: Each 62.5 OR 50/125-micron fiber will be tested patch panel to patch panel at the 850 and 1300 nm wavelength in both directions using a light meter. Each single mode fiber will be tested patch panel to patch panel at the 1310 and 1550 nm wavelength both directions using a light meter. The maximum total attenuation for any single fiber between patch panels will not exceed 2.0 db.

1. Power meter tests: For building risers, power meter tests are required.
2. Provide a power test and OTDR test for length, attenuation, and micro bends for each individual fiber. Documentation will include the power test and OTDR results.
3. Test results included for inclusion into the documentation package.
4. Link attenuation does not include any active devices or passive devices other than cable connectors and splices.
5. A final report shall be complied that records system configuration, fiber labels, cable routes, and as-builts details and as-built drawings.

K. Computer Generated Report: All cables/connectors shall be tested provide test equipment generated print out for each cable/connector, indicating that the channel end-to-end solution has passed or failed. Test results: Provide two cd copies.

L. All testing must meet manufacturer’s warranty requirements.

M. When equipment or systems fail to meet minimum test requirements, replace, or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.

N. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

O. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.10 START-UP

A. All systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

3.11 DOCUMENTATION

A. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of Test Result and draft Record Drawings.

1. Draft drawings may include mark-ups done by hand.
2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.

B. The cabling contractor shall provide the following documentation to the owner within 2 weeks following the completion of the installation:

1. Marked up floor plans identifying as-built cable routing for all horizontal backbone cabling. Submitted in electronic format (AutoCAD) and hard copy print out.
2. Marked up floor plans with station outlet identifier listed adjacent to each station outlet. Submitted in electronic format (AutoCAD) and hard copy print out. In addition, the contractor will provide full size laminated prints or framed prints installed by the contractor in each ER and each TR. All required full size drawings installed as required in each TR and ER to reference all station outlets served by a specific ER or TR.
3. Test results for each jack in each station outlet compiled in a binder with the tests listed in numerical order grouped by ER/TR. Provide two CD copies.
4. Tests results for all horizontal and backbone UTP, Co-Ax and fiber cables complied in a binder with the tests grouped by the backbone cable. Provide two 8-1/2 x 11 hardcopies in notebooks and 2 CD copies.
5. A scaled plan of each building showing the placement of each individual item of equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.

C. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

D. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.

1. Owner may also perform independent testing to verify results.
2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

E. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.

F. Refer also to Technical Sections for requirements specific to covered subsystems.

3.12 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.

C. Thoroughly clean equipment of stains, paint spots, dirt, and dust. Remove temporary labels not used for instruction or operation.

3.13 CODES, PERMITS, AND FEES

1. Comply with all applicable laws, ordinances, rules, regulations, codes, or rulings of governmental units having jurisdiction as well as standards of the National Fire Protection association and serving utility requirements.
2. Obtain and pay for all permits, fees, inspections, utility connections and extensions and the like associated with work in each section of this division.
3. Comply with SCO for inspections as required.

END OF SECTION 270000

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS 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 SCOPE

A. This section includes product and execution requirements for Grounding and Bonding that are unique to communications systems and not included in Division 26 sections.

1.3 DESCRIPTION

A. Grounding and Bonding infrastructure for communications includes Cabling, Busbars and Connectors.

1.4 RELATED WORK

A. Section 270000 - General Communications Requirements

B. Section 270528.33 - Raceway and Boxes for Communications Systems

C. Section 270528.36 - Cable Tray for Communications Systems

D. Section 270553 - Communications Systems Identification

E. Section 271000 - Structured Cabling

F. Section 271100 - Communications Equipment Room Fittings

G. Section 271300 - Communications Backbone Cabling

H. Section 271500 - Communications Horizontal Cabling

I. Related sections in other Divisions of Work:

1.5 REFERENCES AND STANDARDS

A. Refer to Section 270000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition, the following apply:

1. IEEE/ANSI 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.
3. UL 467 Electrical Grounding and Bonding Equipment
4. ANSI J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

1.6 DEFINITIONS

A. Refer to Section 270000 - General Communications Requirements which provides information on Definitions used in this and related sections.

B. Additional definitions (per referenced standards):

1. Telecommunications Main Grounding Busbar: Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to building service equipment (power) ground.
2. Telecommunications Grounding Busbar: Interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground and located in telecommunications room or equipment room.
3. Telecommunications Bonding Conductor: Conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
4. Telecommunications Bonding Backbone: Conductor that interconnects tele-communications main grounding busbar to telecommunications grounding busbar.
5. Grounding Equalizer: Conductor that interconnects elements of telecommunications grounding infrastructure.
6. Exothermic Weld: Method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
7. Irreversible Compression: Permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.

1.7 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 270000 - General Communications Requirements which provides information on Abbreviations and Acronyms used in this and related sections.

B. Additional abbreviations and acronyms (per referenced standards):

1. Telecommunications Main Grounding Busbar - TMGB
2. Telecommunications Grounding Busbar - TGB
3. Telecommunications Bonding Backbone - TBB
4. Grounding Equalizer - GE

1.8 WORK BY OWNER

A. Refer to Section 270000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.9 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

1.10 QUALITY ASSURANCE

A. Refer to Section 270000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

1.11 GUARANTEE

A. Refer to Division 1, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS BUSBARS

A. Material: Copper (aluminum not permitted)

1. 1/4" thick

B. Pre-drilled

1. 3/8" Diameter
2. Hole spacing per ANSI Joint Standard J-STD-607-A
3. Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Busbars shall be listed by nationally recognized testing laboratory.

E. Size:

1. Telecommunications Main Ground Busbar (TMGB) - 20" x 4" (minimum)
2. Telecommunications Grounding Busbar (TGB) - 12" x 4" (minimum)

2.2 CONDUCTORS

A. Material: Solid copper (aluminum not permitted)

B. Bonding Conductors shall be insulated.

1. Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines

C. Size:

1. Telecommunications Bonding Conductor (TMGB to Grounding Electrode): 4/0 AWG
2. Telecommunications Bonding Backbone (TBB; TMGB to TGB): 4/0 AWG
3. Grounding Equalizer (GE): 4/0 AWG

2.3 CONNECTIONS

A. Mechanical Connectors

1. Connector Body shall:

a. Be high-strength, high-conductivity cast copper alloy
b. Be 2 bolt type

2. Bolts, nuts, washers, and lock-washers: Silicon Bronze

a. Shall be supplied as part of connector body
b. Split bolt connector types are not allowed

3. Connector shall:

   a. Meet or exceed UL 467
   b. Be clearly marked with catalog number, conductor size and manufacturer.

B. Compression Connectors

1. Connector Body: pure wrought copper.

   a. Conductivity shall be no less than 99% by IACS standards.

2. Connector shall:

   a. Meet or exceed performance requirements of IEEE 837, latest revision
   b. Be factory filled with an oxide-inhibiting compound
   c. Be clearly marked with manufacturer, catalog number, conductor size and required compression tool settings

3. Connection shall be irreversible.

C. Exothermic Weld Connections

1. Not Allowed

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

A. Permanently attach communications grounds prior to energizing communications equipment.

3.2 TOPOLOGY

A. Refer to the project drawings.

3.3 INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Grounding infrastructure as specified.

B. Install Products in accordance with manufacturer's instructions.

1. Install Compression Connectors with compression, tool and die system, as recommended by manufacturer of connectors.

C. Grounding connections shall be tight and shall be made with UL listed grounding devices, fittings, bushings, etc.

D. On the Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) all connections shall be Compression or Exothermic type.

E. Locate TGBs and TMGB per drawings. The grounding bar location is mounted above the horizontal cable tray in the TR/IDF or MDF.

F. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

1. TGBs shall be bonded to TBB via tap off of TBB.

a. Exception is "last" TGB on TBB (e.g. furthest from TMGB).

2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.

G. Insulate Busbars from their support.

H. Connections shall be bare metal to bare metal contact.

1. Clean surfaces of paint, dirt, oil, etc.,

I. Connections shall be exposed and visible for inspection at all times.

1. Do not install insulation over ground connections.

J. Terminate each grounding conductor on its own terminal lug.

1. Multiple conductors on single lug not permitted.

3.4 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test resistance of each TGB to ground.

1. Maximum resistance to ground shall be less than 5 Ohms.

3.5 DOCUMENTATION

A. Accurately record actual locations of grounding electrode(s), busbars, and backbone grounding conductors.

END OF SECTION 270526

SECTION 270528.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS 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 SCOPE

A. This section includes product and execution requirements for items unique to communications systems and not included in Division 26 sections.

B. Refer to Section 270000 – General Communications Requirements and 260529 - Hangers and Supports for Electrical Systems - Part 1 for requirements for Reference Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee.

1.3 RELATED WORK

A. Section 260529 - Hangers and Supports for Electrical Systems

B. Section 270000 - General Communications Requirements

C. Section 270528.33 - Raceway and Boxes for Communications Systems

D. Section 270528.36 - Cable Tray for Communications Systems

E. Section 271000 - Structured Cabling

F. Section 271100 - Communications Equipment Room Fittings

G. Section 271300 - Communications Backbone Cabling

H. Section 271500 - Communications Horizontal Cabling

PART 2 - PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 260529 - Hangers and Supports for Electrical Systems - Part 3 for:

1. Hanger Rods
2. Beam Clamps
3. Wall Anchors
4. Metal Framing

2.2 J-TYPE CABLE SUPPORT HOOKS

A. Shall not be used on telecommunications cabling covered by Division 27.

PART 3 - EXECUTION

3.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Ceiling support shall not exceed manufacturer specification for Category 6 compliance.

1. The maximum span distance will not exceed 5 feet intervals with a maximum of 12 inches of sag between supports.
2. There shall be a minimum distance of 3 inches between the cable support distance and ceiling grid.
3. Cable pathways design is to avoid EMI and RFI Interference. Common causes of this interference are fluorescent lighting fixtures, air handling motors, and many kinds of electrical controls including starters, lighting contractors, and power distribution panels. All cable runs must be at least two feet away from all fluorescent lights and EMF sources. Never run parallel with electrical conduits or strap to them.
4. Every cable, whether an individual or grouped together, shall be supported.
5. Wherever possible, group cables together in pathways. Never cinch plastic cable ties overly tight. If it deforms the outer cable jacket, it is too tight. The ties should be trimmed of any excess length and be snug.
6. Cable splicing is not permitted, and violation corrections will be at the contractor's expense.

B. Refer to Section 260529 - Hangers and Supports for Electrical Systems - Part 3 for all products identified in Part 1.

END OF SECTION 270528.29

SECTION 270528.33 - RACEWAY AND BOXES FOR COMMUNICATIONS 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 SCOPE

A. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

1.3 DESCRIPTION

A. Refer to Section 260533 - Raceway and Boxes for Electrical Systems - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:

1. Outlet Boxes
2. Pull and Junction Boxes
3. Raceways and Wireways (including sleeves, expansion fittings, penetrations and seals)
4. Indoor Service Poles
5. Poke-through Fittings
6. Floor Boxes
7. Cable Supports

1.4 RELATED WORK

A. Section 260533 - Raceway and Boxes for Electrical Systems

B. Section 270000 - General Communications Requirements

C. Section 270526 - Grounding and Bonding for Communications Systems

D. Section 270528.29 - Hangers and Supports for Communications Systems

E. Section 270528.36 - Cable Tray for Communications Systems

F. Section 270553 - Communications Systems Identification

G. Section 271000 - Structured Cabling

H. Section 271100 - Communications Equipment Room Fittings

I. Section 271300 - Communications Backbone Cabling

J. Section 271500 - Communications Horizontal Cabling

PART 2 - PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 260533 - Raceway and Boxes for Electrical Systems - Part 2 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

B. Telecommunications outlet boxes for voice and data wiring shall be 4-11/16” square x 3-1/4” deep with single gang ring and faceplate.

C. Flexible conduit usage shall be permitted in certain situations where it is the only practical alternative. But it must be approved by the owner before installation. If flexible conduit is used, its size increases by one trade size relative to the size of a rigid conduit.

D. Provide Blank faceplates for all empty device boxes (including low voltage systems provided by others)

2.2 COMMUNICATIONS RACEWAYS

A. OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY (INNERDUCT)

1. UL 2024; flexible type, approved for plenum or riser as may be required for the application installation.
2. Outdoor Innerduct: Smooth outside and ribbed inside
3. Indoor Innerduct: Corrugated.
4. Color:
   a. Riser: Orange.
   b. Plenum: Orange.
5. Manufacturers: Carlon; Pyramid; or Approved equal.

2.3 MULTI-CELL FLEXIBLE RACEWAY

A. Innerduct shall be a flexible, multi-celled, textile innerduct system designed for communications.

B. Innerduct shall meet the following physical requirements:

1. Tensile strength: 2500-lbs or better
2. Melting Point: 480-degrees F or better
3. Resistant to ground chemicals and petroleum products
4. Unaffected by mud, silt or debris after placement of cable.

C. Innerduct shall be pre-lubricated for lower friction during innerduct and cable installation.

D. Innerduct Color shall be WHITE.

1. Innerduct shall include a color-coded stripe allowing for identification of each bundle.

E. Each cell shall include a color-coded pull tape.

F. Product shall be available in a variety of sizes and cell counts. Refer to project Drawings.

PART 3 - EXECUTION

3.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 260533 - Raceway and Boxes for Electrical Systems - Part 3 for Outlet Boxes for Communications, Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

3.2 COMMUNICATIONS RACEWAYS

A. Optical Fiber Communications Cable Raceway (Innerduct):

1. Minimum innerduct size: 1 1/4”, unless otherwise noted on drawings.
2. Extend innerduct to termination and/or storage enclosure.
3. Install couplings designed for innerduct size and type where innerduct enters a termination and/or storage enclosure.
4. Splice innerduct segments using couplings designed for that purpose, where not installed in a continuous length.
5. Install 200 lb nylon pull cord in empty innerduct. Leave at least 12” of slack at each end of pull wire. Cap innerduct at both ends.
6. Label innerduct with tags indicating cable type and cables contained therein.

   a. Label in each maintenance hole, pull box and communications equipment room, where exiting a conduit and at 10 ft intervals in cable tray or where otherwise exposed.

3.3 MULTI-CELL FLEXIBLE RACEWAY

A. Segment conduits to increase capacity.

1. Provide quantity and size per project Drawings.

B. Install per manufacturers recommendations.

3.4 RACEWAY INSTALLATION

A. Provide cable tray above hallways with full conduit from the wall outlet. Conduit shall be stubbed within 6 inches of the cable tray and bonded.

B. AV and security cabling shall be in dedicated raceways. It shall not be installed in the cable tray dedicated to Data/Telecom.

END OF SECTION 270528.33

SECTION 270528.36 - CABLE TRAYS FOR COMMUNICATIONS 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 RELATED WORK

A. Section 260000 - General Electrical Requirements

B. Section 260526 - Grounding and Bonding

C. Section 260529 - Hangers and Supports for Electrical Systems

D. Section 260533 - Raceway and Boxes for Electrical Systems

E. Section 260593 - Electrical System Firestopping

F. Section 270000 - General Communications Requirements

G. Section 270526 - Grounding and Bonding for Communications Systems.

H. Section 270528.29 - Hangers and Supports for Communications Systems

I. Section 270528.33 - Raceway and Boxes for Communications Systems

J. Section 271000 - Structured Cabling

K. Section 271100 - Communications Equipment Room Fittings

L. Section 271300 - Communications Backbone Cabling

M. Section 271500 - Communications Horizontal Cabling

1.3 SCOPE

A. Provide a cable tray system including straight tray sections, fittings such as horizontal elbows, vertical risers, crosses, tees, wyes, reducers and coupling accessories, splice plates and cable tray supports to support cable systems in locations as indicated on drawings.

B. Cable tray system is intended to carry telephone, data and low voltage communications cable only; power wiring, AV, fire alarm system, HVAC, area of refuge, and security cabling shall not be permitted in the cable tray systems.

C. Cable pathways shall be so designed to avoid EMI and RFI interference. Common causes of this interference are fluorescent lighting fixtures, air handling motors and many kinds of electrical controls, including starters, lighting contactors and power distribution panels.

1. All cable runs must be at least 2’ away from all fluorescent lights and EMF sources. Any violations of this rule will be corrected at the contractor’s expense.

2. Never run parallel with electrical conduits or strap to them.
3. Every cable, whether an individual or grouped together, shall be supported.
4. Wherever possible, cables shall be grouped together in pathways.
5. Plastic cable ties (zip ties) shall not be used or allowed under any circumstance. Hook-and-loop type fasteners shall be used instead. Fasteners shall be snug but shall not crimp cabling and installed in a clean and professional manner.

1.4 REFERENCE STANDARDS

A. UNCW ITS Communications Design and Construction Guidelines

B. ASTM A 123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and forged Steel Shapes, Plates, Bars, and Strip.

C. ASTM A 446 - Specification for Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality.

D. ASTM A 525 - Specification for Steel Sheet, Zinc-Coated Galvanized by Hot Dip Process.

E. ASTM A 607 - Specification for Steel Sheet and Strip, Hot-rolled and Cold-Rolled, High Strength, Low Alloy Columbium or Vanadium.

F. ASTM B 633 - Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

G. NEMA VE 1 - Metal Cable Tray Systems.

H. NEMA VE 2 - Cable Tray Installation Guidelines

I. BICSI - Telecommunications Distribution Methods Manual (TDMM)

J. STS-1000 Telecommunications Wiring Guidelines. Rev 07 / 25 / 06

1.5 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. As-built drawings showing floor plan location and conduit drops.

C. Coordination Drawings shall be required under this section for communications systems cable trays, showing relationship to other trades (mechanical, plumbing, electrical, etc.) Coordination drawings shall provide elevation of cable tray and elevation of other trades equipment / routing.

PART 2 - PRODUCTS/MATERIALS

2.1 MANUFACTURER

A. Acceptable Manufacturers

1. Cooper B-Line (FLEXTRAY™)
2. Chalfant Cable Trays
3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
4. GS Metals Corp.; GLOBETRAY Products
5. Mono-Systems (Mono-Mesh™)
6. Legrand (CABLOFIL®)

2.2 CABLE TRAY

A. Be installed 3” above ceiling tile and have a minimum of 12” clearance to one side and above.

B. Be structurally supported at every 10’ MAXIMUM.

C. Be free of any sharp edges

D. Tray shall be continuous, rigid, welded steel wire mesh cable management system.

E. Maximum mesh dimension shall be 2 x 4 inches (50 x 100 mm).

F. Wire diameter shall be at least 5 mm.

G. Material shall be carbon steel wire, ASTM A510, Grade 1008. Wire welded, bent, and surface treated after manufacture

H. Finish shall be Electro-Plated Zinc Galvanizing per ASTM B 633, Type III, SC 1 or Electro-plated yellow zinc dichromate in accordance with ASTM B 633, Type III, SC 2.

I. Dimensions:

1. Inside width: As indicated on Project Drawings
2. Loading depth (NEMA VE 1): 4" minimum

J. Tray system shall not present sharp edges, burrs or projections injurious to wiring.

K. Hardware, including splice connectors and support components, shall be furnished by tray manufacturer.

L. Tray shall be UL classified for use as an equipment grounding conductor.

M. Tray shall be designed to support volume capacity of cables and provide safe mechanical support for spans up to 8 feet (2.4 meters) on center. Tested load deflection data is available either in accordance with NEMA VE 1 or IEC 61537 standards

N. Splice plates shall be bolted type made specifically for tray type provided.

O. Splice plate construction shall be designed to permit splice location at any point within support span without diminishing cable tray rated loading capacity.

P. Supports shall comply with product requirements defined in specification section 26 05 29 - Hangers and Supports for Electrical Systems.

Q. Flexible cordage/wire shall not be used.

2.3 J-HOOKS

A. The use of J-hooks for data and voice must be approved by UNCW ITS during the design phase.

B. J-hooks for all other low voltage systems (AV, Paging, Fire Alarm, etc.) must meet the following

1. Comply with UL, cUL, NEC and EIA/TIA requirements for structured cabling systems.
2. Be capable of being installed in a single- or multiple-hook (“tree”) configuration.
3. Minimum vertical spacing shall be 12”.
4. There shall be a minimum distance of 3” between the cable support and the ceiling grid.

5. Incorporate a latch or other mechanism to retain cable.
6. Shall be placed on 4'-0" center-to-center MAXIMUM with a maximum 12" of sag between supports. Any further spacing shall be cause to have them removed and replaced at contractor expense with proper spacing maintained.
7. Shall be broad saddle type with minimum of 1 ¼" support for cabling, radiused to provide proper support and no kinking.
8. Shall not cause cables to be strained.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cable tray shall be installed in corridors and above lay-in ceilings only. No cable tray is to be installed above a hard ceiling space unless it is under 3'-0" in length.

B. No cabling shall be supported to the outside or underneath the cable tray system.

C. Tray system shall be accessible at all locations. Sufficient space shall be provided about cable trays to permit side access for installing and maintenance of cables. Minimum of 12" on each side of cable tray and 12" above shall be provided. Any access less that 12" shall be approved by engineer and owner.

D. Cable tray shall be installed at consistent height above installed ceiling. Installed cable tray height shall be allowed to deviate along floor but shall remain at minimum of 3" above accessible ceiling and maximum of 6" above accessible ceiling. Any deviation from constant height installation shall be coordinated and approved by engineer and owner. Deviation from constant installation height per floor shall be by manufacturers prefabricated part designed for this purpose. Constant height installation shall be goal of initial design and coordination drawings.

E. Cable tray shall be installed:

1. Minimum of 3" off wall
2. Maximum of 6" off wall

F. Provide blind end plates for trays that dead end.

G. Provide full-width dropouts where cable exit from tray.

H. Join cable tray system sections at ends using manufacturer prefabricated splice plates.

I. Provide prefabricated expansion splice plates where cable tray systems cross building expansion joints.

J. Trapeze hangers are not permitted to support the cable tray.

K. Cable tray shall be supported by threaded rods that comply with manufacturer's recommended support and loading requirements.

L. Total vertical tray deflection shall not exceed manufacturer's recommendations.

M. Cable shall be equally distributed between both sides of the cable tray to equally distribute weight of cables

N. Size, anchor, and space supports to sustain weight of cable tray system, cable and tubes which are to be installed into cable tray, and 200 lbs excess on any individual ladder rung or section, with safety factor of 1.5 minimum when supported as simple span and tested per NEMA requirements. Load and safety factors are applicable to both, rung or section and side rails.

O. Calculate supports based on 100 lbs/ft load of cables and tubes.

P. Total vertical tray deflection shall not exceed 1-1/2" between supports.

Q. Include dynamic loads in calculations for outside area installations.

R. Make intersections, bends, and tees, using fittings of same type and model series as straight run sections.

S. Cable tray systems shall be electrically continuous.

T. Connect each cable tray system subassembly to building ground system using grounding clamps and grounding conductors. Provide 3.0 ohm maximum resistance to building ground connection.

U. Copper grounding conductors shall not be installed on aluminum tray systems.

V. Cable tray shall not be connected to instrumentation grounding system.

W. Structural side members shall not be punched or drilled except for splice-plate and fastener bolt holes.

X. Cable tray system components shall not be flame-cut or arc-cut. Make cuts using a saw.

Y. Drill or punch holes for splice-plates and fasteners and remove burrs.

Z. Provide blind end plates for trays that dead end.

AA. Conductor Installation:

1. Provide metallic grounding conduit clamps to attach conduits to cable tray system.
2. Provide bushings on conduit ends where cables enter conduit to protect insulation.
3. Make multiple drops at ends of sections using manufacturer prefabricated ladder drops.
4. Plastic, prefabricated closure straps (tie-wrap or zip-tie type) shall not be allowed. Hook-and-loop style fasteners shall be used to secure cables in cable tray system.
5. Strap vertical runs as required, to prevent sagging of cables.
6. Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.

END OF SECTION 270528.36

SECTION 270553 - COMMUNICATIONS SYSTEMS IDENTIFICATION

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 SCOPE

A. This section details product and execution requirements for labeling of communications cabling, termination components, pathways and spaces for Communications Systems.

B. Labeling is a critical requirement and should be attended to in detail.

1.3 DESCRIPTION

A. All components shall be clearly labeled to identify them as unique throughout the project.

B. Labeling requirements include identification of Rooms, Equipment Racks, Telecommunications Outlets, Wireless access points (WAP), Horizontal and Backbone Cabling, Termination Hardware (Patch Panels, Blocks) and Grounding.

C. Building IDs and room numbers are assigned by UNCW Facilities. The Contractor should check with the UNCW project manager to ensure the proper building ID and room numbers are used when labeling communications systems components.

1.4 RELATED WORK

A. Section 270000 - General Communications Requirements

B. Section 270526 - Grounding and Bonding for Communications Systems

C. Section 271000 - Structured Cabling

D. Section 271100 - Communications Equipment Room Fittings

E. Section 271300 - Communications Backbone Cabling

F. Section 271500 - Communications Horizontal Cabling

1.5 REFERENCES AND STANDARDS

A. Refer to Section 270000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

1. TIA/EIA-606-A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.6 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide general guidelines for product and/or installation information to be submitted by contractor.

B. Contractor shall provide a complete set of as built documents identifying all of the data ports, port numbers, racks each port is associated with and wiring diagrams fully describing the complete field conditions.

1. Marked up floor plans identifying as-built cable routing for all horizontal backbone cabling. Submitted in electronic format (AutoCAD) and hard copy print out.
2. Marked up floor plans with station outlet identifier listed adjacent to each station outlet. Submitted in electronic format (AutoCAD) and hard copy print out. In addition, the contractor will provide full size laminated prints or framed prints installed by the contractor in each ER/MDF and each TR/IDF. All required full size drawings installed as required in each TR and ER to reference all station outlets served by a specific ER or TR.
3. Test results for each jack in each station outlet compiled in a binder with the tests listed in numerical order grouped by ER/TR. Provide two CD copies.
4. Tests results for all horizontal and backbone UTP, Co-Ax and fiber cables complied in a binder with the tests grouped by the backbone cable. Provide two 8-1/2 x 11 hardcopies in notebooks and 2 CD copies.
5. A scaled plan of each building showing the placement of each individual item of equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.

PART 2 - PRODUCTS

2.1 GENERAL

A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.

B. Professional, non-erasable, adhesive, machine-printed labels shall be used and bear the approved cable identification method. Labels for stainless steel faceplates shall be clear adhesive type with black lettering.

C. Cable labels shall be self-laminating, White/Transparent Vinyl and incorporate an integrated clear lamination which, when label is wrapped around cable, covers printed part of label.

1. Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.
2. Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.

PART 3 - EXECUTION

3.1 GENERAL

A. Labeling shall be by mechanical means.

1. Hand lettered designations are not allowed.

B. Tags shall be non-removable.

1. Exceptions:

a. Telecommunications Outlet labels that are placed in recessed label holders.
b. Telecommunications Ground tags secured with cable ties.
c. Innerduct Tags secured with cable ties.

C. Characters shall be Black Ink and printed on background of contrasting color.

D. Labels shall match hardware layout and design.

E. Labels shall be as large as practicable while fitting properly.

F. No lettering shall be smaller than 10-point.

G. Label cables with tag which is wrapped around cable sheath.

H. The contractor will provide labels with the following criteria. Each end of all Category 6 cable labeled at approximately 3 to 6 inches from the Network Data/voice jack, CATV, and with a printed cable label. The contractor with consultation will provide labeling for the faceplate and block terminations from the Information Technology Network Group. All labeling will comply with the TIA-606A standard. The ER/TR labeling nomenclature will match that of the station outlet (SO) identifier as shown in the following information.

I. The general numbering sequence shall conform to a sequential numbering pattern common to all floors of the facility. All cable numbering is sequentially from room to room as closely as possible. The final numbering scheme agreement is between the selected vendor and the building owner, UNCW prior to the start of the physical installation.

J. TIA-606 Administration standards for the Network Communications Infrastructure of Commercial Buildings is an incorporated reference. Compliance and shall be maintained.

K. Each cable record must indicate the cable type by manufacturer and manufacturer's designation and document every pair/conductor in the cable. Cable identifier linkage is to all pathways in which it runs.

L. Each piece of termination hardware such as a patch panel or wiring block must be unique named and labeled.

M. Termination position on cross-connect must be identified by type, the pair conductor terminated and a user code.

N. Each element in the route, identification labels should be completed and attached. Labels should meet the requirements of UL969 Standard for Marking and Labeling Systems.

O. A final report should record system configuration, unique identifier, fiber labels, pathways, as-built details, and as-built drawings.

P. Loss Measurements and OTDR traces shall also be included. With the records.

Q. Color coding to match 606 requirements.

3.2 ROOM IDENTIFICATION

A. Label Communications Backboard or Equipment Rack closest to entry door with unique identifying code.

B. Characters shall be 1-inch minimum.

C. Room ID shall be by permanent method

3.3 RACK-MOUNTED 110-BLOCK LABELING:

A. Each 110-block position (each 4-pair connector clip) will be labeled as follows: Standard SOs/ wall phones outlets FVXX- where FVXX is the SO identifier where the Category 6 or beyond Category 6 cable on that connector clip terminates.

3.4 PATCH PANEL LABELING:

A. Modular patch panel labeling: Each panel has labeling. Each modular jack panel position shall be XXX where XXX matches the SO identifier. The patch panel shall have a label placed on the upper left hand corner of the panel face identifying the panel. All labels for the labeling printed using a computer, printer or Brother p-touch labeler with the TZ tape or equivalent. LABELS SHALL NOT BE HANDWRITTEN. Labels shall be different colors as detailed for identification per the 606B standard. The contractors shall meet with UNCW Telecom personnel, verify the numbering schemes, and label coloring

3.5 STATION OUTLET LABELING:

A. Consists of two components: top faceplate label and a bottom faceplate label. The label will consist of a five-character identifier with the format f-y-xxx. F= the floor number of the building, y is D for data or V for voice and xxx is a unique identifier between o and 999 for any station outlet on that floor served by the same ER/TR. Faceplate labels for wall phones will consist of 4-character identifier with the format f-v-xxx. F= the floor number, V = is for voice, xx is a unique identifier between 0 and 99.

3.6 CABLE NUMBERING:

A. Shall follow the example:

1. D=DATA, V=VOICE
2. 5=NETWORK COMMUNICATIONS ROOM NUMBER
3. 2=FLOOR NUMBER
4. 013=13TH CABLE TO BE INSTALLED
5. EX: CABLE D.5.2.013

3.7 WIRELESS ACCESS POINT LABELING:

A. Label the grid work at the outlet location with a printed label. Provide WAP in front of the horizontal cable label at the rack end. A green dot on the grid work is for easy location identification.

1. Example: WAP D.5.2.013

3.8 FIBER LABELING:

A. The interconnect panel will be labeled on the front glass of the enclosure and include:

1. Size and type of the fiber.
2. The far end or “TO” will be shown
3. The building the fibers termination point location is.
4. The Enclosure will be identified.
5. The interconnect panel will be identified.

B. Panel A 12 SM to (bldg. abbreviation) Enclosure (A thru Z identified on enclosure) to Panel A thru Z identified on enclosure)

1. EX. Panel A 12 SM to TSC Enclosure D Panel G.

END OF SECTION 270553

SECTION 271000 - STRUCTURED CABLING

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 SCOPE

A. This section details product and execution requirements for Structured Cabling for Communications Systems.

1.3 DESCRIPTION

A. Systems shall include cabling, termination hardware and active components, installed as indicated on drawings and specifications.

B. Cables and equipment shall be provided, tested, and terminated, including proper grounding and bonding.

C. The SCS Solution shall utilize a network of fiber optic and unshielded twisted pair, riser, ty and station cables. Cables and terminations located as shown and in the quantities indicated on the drawings. Fiber cables shall terminate on wall- or rack-mounted fiber patch panels located in all demarcation and termination points shown on the drawings. All cables shall terminate in an alphanumeric sequence at all termination locations. All standard copper cable terminations shall comply with, and be tested to latest revision of TIA-568-C family of standards for Category 6 and/or beyond Category 6 installations. Horizontal cabling for wireless access points (WAPs) shall comply with, and be tested to latest revision of TIA-568-C family of standards for Category 6A and/or beyond Category 6 installations. Available and unused pairs between the Equipment Room (ER) and Telecommunications Room(s) (TR) shall terminate and identified as spare at each location. Station cables shall terminate on three or four gang wall plates equipped as shown on the drawings. All copper terminations will be T-568B wiring.

D. The SCS solution for standard cable drops shall support a useable end-to-end system bandwidth of not less than 400 MHz. This requires substantial performance margin in all key electrical parameters beyond Category 6. Useable end-to-end system bandwidth is indicated by the maximum frequency at which a positive Power Sum Attenuation-to-Crosstalk Ratio may be obtained at both the Near (PSACRN) and Far ends (PSACRF) of a 100-meter cabling channel. This channel shall have the capability of four or six connections without failing to meet Category 6 specifications. The required cabling system described is a “Beyond Category 6” structured cabling solution.

E. The SCS solution for wireless access points (WAPs) shall support a useable end-to-end system bandwidth of not less than 500 MHz. This requires substantial performance margin in all key electrical parameters beyond Category 6A. Useable end-to-end system bandwidth is indicated by the maximum frequency at which a positive Power Sum Attenuation-to-Crosstalk Ratio may be obtained at both the Near (PSACRN) and Far ends (PSACRF) of a 100-meter cabling channel. This channel shall have the capability of four or six connections without failing to meet Category 6A specifications. The required cabling system described is a “Beyond Category 6A” structured cabling solution.

1.4 RELATED WORK

A. Section 270000 - General Communications Requirements

B. Section 270526 - Grounding and Bonding for Communications Systems

C. Section 270528.29 - Hangers and Supports for Communications Systems

D. Section 270528.33 - Raceway and Boxes for Communications Systems

E. Section 270528.36 - Cable Tray for Communications Systems

F. Section 270553 - Communications Systems Identification

G. Section 271100 - Communications Equipment Room Fittings

H. Section 271300 - Communications Backbone Cabling

I. Section 271500 - Communications Horizontal Cabling

1.5 REFERENCES AND STANDARDS

A. Refer to Section 270000 - General Communications Requirements which identifies pertinent References and Standards.

B. In addition:

1. TIA/EIA 568-B.1 through B.3 - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
2. TIA/EIA 569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
3. BICSI Telecommunications Distribution Methods Manual (TDMM)
4. TIA/EIA-758 - Customer-Owned Outside Plant Telecommunications Cabling Standar]
5. TIA/EIA-862 - Building Automation Systems Cabling Standard for Commercial Buildings
6. TIA-942 - Telecommunications Infrastructure Standards for Data Centers
7. TIA/EIA-598-C: Optical Fiber Cable Color Coding.
8. TIA/EIA 455-21-A: Mating Durability for Fiber Optic Interconnecting Devices
9. TIA/EIA 526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
10. TIA/EIA-526-7: Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant
11. UL-910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
12. UL-1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
13. IEEE 802.3af and 802.3at PoEPlus (latest draft) Power-over-Ethernet Standards.
14. IEEE 802.3an 10 Gigabit Standard

1.6 DEFINITIONS

A. Refer to Section 270000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction:

1. Backbone Cabling - cable or conductors between telecommunications rooms, or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings. Backbone cabling may be twisted pair copper, fiber optic or coaxial.
2. Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
3. Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
4. Channel-end-to-end transmission path to which application-specific equipment is connected. Same as "Permanent Link", but also includes patch cords at Telecommunications Outlet and in Telecom Room.
5. Consolidation Point: A location for interconnection between horizontal cables extending from the horizontal cross-connect and horizontal cables extending to the telecommunication outlet at the workstation.
6. Contractor: Telecommunications Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of communications cabling, termination components, pathway hardware, telecommunications equipment room hardware and related components detailed in technical sections of this Division of work.
7. Cross-Connect - group of connection points between cabling runs and/or equipment used to administer building wiring using patch cords or wire jumpers.
8. Horizontal Cabling - Cables connecting Telecommunications Outlets to horizontal or intermediate cross-connect. Sometimes referred to as "Station Cabling".
9. Horizontal Cross-connect – Connection of horizontal cabling to other cabling (e.g. horizontal, backbone or equipment) using patch cords or wire jumpers.
10. Interconnection - Connection scheme using connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper
11. Main Cross-connect – Connection between backbone cables, entrance cables and equipment cables using patch cords or wire jumpers.
12. Outlet ID - unique alpha-numeric identification used for referencing Telecommunications Outlet or connectors therein.
13. Permanent (Cable) Link - includes Telecommunications Outlet, horizontal (station) cable and termination hardware in Telecom Room.
14. Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.
15. Telecommunications Outlet - device assembly located in work area on which horizontal cabling terminates and which can receive modular connectors. It is interface between Station Cable and end user's equipment.
16. Telecom Room - an enclosed space for housing telecommunications equipment, horizontal and backbone cable terminations, and cross-connect cabling, that is recognized location of horizontal cross-connect.
17. Zone Box - An enclosure used to house one or more of the following; a) a consolidation point, b) a horizontal connection point, c) building automation system outlets.
18. Zone Cabling - Extends permanent horizontal cabling to a shared termination (consolidation) point in the work area. Passive system extends link to workstation through at interconnect at the Consolidation Point (CP). Active system includes system electronics at the CP.

C. “10-gigabit” or “10G” performance criteria, if applicable, refers to support of 10GBASE-T application over 4-connector channel up to 100-meters and meeting requirements of TIA-568-B.2-10 “Transmission Performance Specifications for 4-Pair 100 Ohm Augmented Category 6 Cabling”.

1.7 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 270000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction:

1. 8P8C Eight-Position, Eight-Conductor. Used in clarifying jack type; a.k.a. "RJ-45".
2. CM Communications cable rated for General Purpose use
3. CMP Communications cable rated for use in Plenum areas
4. CMR Communications cable rated for use in Risers and vertical runs
5. CP Consolidation Point
6. ELFEXT Equal-Level Far-End Cross Talk (pair-to-pair)
7. FEXT Far-End Cross Talk
8. F/UTP Foiled Unshielded Twisted Pair
   a. No shielding around individual pairs and an overall foil shield under the cable jacket
9. HC Horizontal Cross-connect
10. HCP Horizontal Connection Point (e.g. for TIA-862)
11. IDF Intermediate Distribution Frame
12. MC Main Cross-connect
13. MDF Main Distribution Frame
14. N Newton
15. NEXT Near End Cross Talk
16. OFNP Optical Fiber Nonconductive Plenum
17. OFNR Optical Fiber Nonconductive Riser
18. OTDR Optical Time Domain Reflectometer
19. PBX Private Branch Exchange (Telephone Switch)
20. PoE Power-over-Ethernet
21. PSNEXT Power Sum Near End Cross Talk
22. S/FTP Screened Foiled Twisted Pair
    a. (Individual foil shield around each individual pair and an overall braided shield under the cable jacket.)
23. S/UTP Screened Unshielded Twisted Pair
    a. (No shielding around individual pairs and an overall braided shield under the cable jacket.)
24. SF/UTP Screened Foiled Unshielded Twisted Pair
    a. (No shielding around individual pairs and overall foil and braided shields under the cable jacket.)
25. TO Telecommunications Outlet
26. TR Telecommunications Room
27. USOC Universal Service Order Code
28. UTP Unshielded Twisted Pair
    a. (No shielding around pairs nor overall under cable jacket.)
29. U/FTP Unshielded Foiled Twisted Pair
    a. (Individual foil shield around each individual pair and no overall braided shield under the cable jacket.)

1.8 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. In addition, Submit:

1. Contractor Certification documents which document their participation in Installers Program operated by Manufacturer of Cabling or Termination Components used.

   a. Certified Installer(s) assigned to Project shall be identified to Engineer.
   b. Provide current BICSI standing of all installers.

1.9 QUALITY ASSURANCE

A. General:

1. Cable and Equipment Manufacturer(s) shall be company specializing in communications cable, accessories and/or equipment with minimum of 10 years documented experience in producing cable, accessories and/or equipment similar to those specified herein. The structured cabling system (SCS) for this project shall implement a complete end-to-end solution. Cable and Equipment Manufacturer(s) shall provide a complete end-to-end solution that has been designed to work as a system. This will include, but not be limited to, patch panels, patch cables, terminations, cabling and any such components, parts and pieces that either make the products work as a system or enhance its overall performance and/or reliability over the course of its lifetime. Several manufacturers provide such systems and the overall intent is that this shall be an approved manufacturers system, not parts and pieces. This extends to all cable types, connectors, terminations and any associated equipment provided under the Division 27 specifications.
2. The preferred SCS are as follows:

B. Contractor Qualifications:

1. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete cable and equipment installation and termination.
2. Contractor shall have been in this business for minimum of 5 years and shall have successfully completed 4 projects equal in magnitude of system specified in the following sections.
3. Contractor personnel must be vendor/manufacture certified to install the complete system. Contractor shall have necessary certifications to provide for Warranty as specified herein.
4. Contractor shall be an active participant in Installers Program operated by Manufacturer of Cabling or Termination Components used. Contractor shall be participant in this program at time of Bidding and remain so throughout project.
5. The contractor shall be a manufacturer certified Business Partner, CVA, or for the TE solution the installers, supervisors, registered certifier, and designers to have a current valid certification card.

   a. The Network Communications project manager must have experience in this type of project and he/she expected to provide technical support.
   b. The Network Communications project manager shall attend the monthly progress meetings held by the state and additional meetings as scheduled or required.
   c. BICSI registration must be current and the installer and technicians must be in good standing.
   d. During the shop drawing process, provide copies of all manufacturer and BICSI certifications, the contractor shall meet the following criteria: 15% of work force shall be BICSI certified ‘Technician level or better (RCDD). 15% of work force shall be BICSI certified Installer level 2 or higher; 15% of work force shall be BICSI certified installer level 1 or of equivalent experience/training.

6. For the preferred solutions:

   a. CommScope SYSTIMAX Category 6 and Category 6A solutions require the contractor to be a current PartnerPRO network member; installers, supervisors, designers to have a current valid certification.
   b. CommScope NETCONNECT/Uniprise Category 6 and Category 6A solutions require contractor to be a current PartnerPRO network member; installers, supervisors, designers to have a current valid certification.

c. Belden solution requires the contractor to be a Belden Partner Alliance (PA) program member.
d. Legrand/Superior Essex solutions require the contractor to be a current Legrand Certified Installer Plus (CIP); installers, supervisors, designers to have a current valid certification.
e. Corning solution requires the installers to be a current EWP.
f. The contractor shall be a manufacturer certified Business Partner, CVA, or for the TE solution the installers, supervisors, registered certifier, and designers to have a current valid certification card.
g. The Network Communications project manager must have experience in this type of project and he/she expected to provide technical support.
h. The Network Communications project manager shall attend the monthly progress meetings held by the state and additional meetings as scheduled or required.
i. BICSI registration must be current and the installer and technicians must be in good standing.
j. During the shop drawing process, provide copies of all manufacturer and BICSI certifications, the contractor shall meet the following criteria: 15% of work force shall be BICSI certified 'Technician level or better (RCDD). 15% of work force shall be BICSI certified Installer level 2 or higher; 15% of work force shall be BICSI certified installer level 1 or of equivalent experience/training.

1.10 GUARANTEE

A. See Division 1, General Conditions, and General Requirements - Guarantee Documents and Section 270000 - General Communications Requirements for general guarantee requirements.

B. Manufacturer Warranty

1. Contractor shall provide a minimum Twenty (20) year cabling Extended Product Warranty and Application Assurance. The warranty will support any performance claims the manufacturer makes over and above the Category 5E/6/6A standards stated herein. A Warranty statement from the Manufacturer stating the period of the warranty for all the products specified for the project and the name and address of the authorized manufacturers agent who will honor the warranty claims.

C. Extended Product Warranty

1. The Extended Product Warranty will cover product defects for all passive manufactured channel components. Passive components are those exhibiting no gain or contributing no energy. Manufacturer warrants, from the date a Registration Certificate passes to the end-user, the following:
2. That the passive products that comprise the registered Channel solution will be free from manufacturing defects in material or workmanship under normal and proper use;
3. That all channel approved passive cabling products that comprise the registered channel solution exceed the specification of TIA 568 and exceed ISO/IEC 11801 standards and will be equal to or exceed to the performance specifications of the associated Communication product data sheet in effect at the time the Registration Certificate is issued;
4. That the installation will exceed the insertion and return loss, attenuation and near end cross talk (NEXT) requirements of TIA 568-B and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards.
5. That each channel is comprised exclusively of a single manufacturer solution and is capable of delivering 1.2 Gbps (Cat 5e), 3.6 Gbps (Cat 6) or 10 Gbps (Cat 6A) to the workstations or WAPs in accordance with applications standards.
6. This extended Product Warranty is applicable to the channel cabling solution products only on the original site of installation. Under the Extended Product Warranty, Manufacturer will either repair or replace the defective product itself at Manufacturers' cost. The U.S.A., Manufacturer will pay an Authorized cable installation Reseller for the cost of labor to repair or replace any such defective product on behalf of Manufacturer.

7. Corning Cable Systems LANscape solutions "landscape extended warranty" a 25-year guarantee on complete fiber optic cabling solutions. The telecom contractor shall be an authorized Corning Cabling Systems extended warranty (NPI) installer.

D. Application Assurance

1. Application Assurance covers failure of the channel SCS to operate the applications, that the Solution is to support, as well as additional application(s) included in the numbered list. Manufacturer warrants that the registered channel SCS solution will be free from failures which prevent operation of the specific applications for which the original channel SCS was designed. The Application Assurance Program also covers the following additional applications:
2. Those identified in the current (at the time of installation) channel SCS Performance Specifications; and
3. In accordance with application standards specifications, any applications introduced in the future by recognized standards or user forums that use TIA/EIA 568 or ISO/IEC 11801 components and link/channel specifications for cabling.
4. The contractor's certifications are current for the manufacturer's solution installation. The contractor shall provide standards compliant, warranted, end-to-end channel solution for structured cabling solutions.

E. Additional Warranty

1. Contractor shall state any additional Contractor supplied warranty. This contractor warrants the Network communications cabling infrastructure system to be free of defects in the materials and workmanship for the period of one year after the date of final payment. The effective date of this warranty applies to all components of these systems regardless of any equipment manufacturer's warranties, which may expire at an earlier date. Any system malfunctions or any previously undiscovered non- compliance with the plans and specifications during the warranty period are repaired at no cost to the Owner are brought into compliance.
2. Self-Install Warranty: The beyond cat 6 structured cabling manufacturers shall issue The University of North Carolina at Wilmington a Self-Install Warranty for all future moves, adds and changes that are warrantied under this contract document 'Extended product warranty and application assurance program for an end-to –end channel solution'.

F. Warranty for structured cable system as follows:

1. 4-pair Category-rated Horizontal Copper Permanent Link for no-less than 25 years from date of owner acceptance of work.
2. Copper Backbone for no-less than 5 years from date of owner acceptance of work. Cabling and Connecting Components shall carry 25-year component warranty.
3. Fiber Optic Backbone for no-less than 25 years from date of owner acceptance of work.

G. Warranty shall be direct from manufacturer of cabling and connecting components to Owner.

1. Warranty through contractor shall not be allowed or approved.

PART 2 - PRODUCTS

2.1 GENERAL

A. The installation contractor shall be responsible for installing, terminating, testing, and labeling the cabling system in accordance with TIA and BICSI installation guidelines for intra and inter building. The contractor will also provide UNCW with a dedicated project manager for the life of the project who is responsible for planning the installation schedule and act as the interface with UNCW employees. Weekly update meetings will be required. The contractor will also provide UNCW with the certified installation warranty certificate at the completion of the project. This will ensure that UNCW will be able to maintain a warranty on their installed communication systems.

B. A single manufacturer shall provide all unshielded twisted pair (UTP) end-to-end Channel (as defined by latest revision of TIA-568-C family of wiring standards) configurations. The horizontal cabling to station outlets shall consist of UTP, riser rated (CMR) cable at a minimum.

C. Each standard data cable shall be 'Beyond' Category 6 rated to a minimum of 400 megahertz and shall be third party verified to comply with or exceed TIA Category 6 requirements.

D. Each cable for wireless access points (WAPs) shall be a "Beyond" Category 6A cable rated to a minimum of 500 MHz. Each cable for WAPs shall be third party verified to comply with or exceed Category 6A requirements and shall carry be capable of supporting 100W Power-Over-Ethernet over 100 meters.

E. Provide riser - rated cabling and install as required with the exception of plenum rated cabling for plenum spaces.

F. All cable and connecting components that comprise the TIA horizontal cabling "Permanent Link" from Horizontal Cross-connect to Telecommunications Outlet shall be compliant with the applicable requirements for "DTE Power via the MDI" to provide at least 30W at the Powered Device as defined by the IEEE 802.3at "Power over Ethernet Plus" (PoEPlus) draft standard.

G. Manufacturers:

1. CommScope SYSTIMAX Solutions GigaSPEED XL Category 6 Structured Cabling System and Corning Cable Systems LANscape solution
2. CommScope SYSTIMAX Solutions GigaSPEED X10D Category 6A Structured Cabling System with x91B reduced diameter cable and Corning Cable Systems LANscape solution (Access Solutions)
3. CommScope NETCONNECT/Uniprise CAT 6 CS37 cabling system and the Corning Cable Systems LANscape
4. CommScope NETCONNECT/Uniprise CAT 6A CS47 cabling system and the Corning Cable Systems LANscape (Access Solutions)
5. Belden System 2400 (for horizontal cabling). 2412 shall be installed. Key Connect work station outlets and Key Connect patch panels.
6. Belden System 10GXS (for wireless access point cabling). Belden System 3612 and/or 10GXS cabling shall use Belden's REVConnect modular termination system, in appropriate category, supporting either jacks or plugs. Belden System 3600 and/or 10GXS cable shall be installed. Optical fiber system shall be Corning Cable Systems LANscape solution.
7. Legrand/Superior Essex nCompass Clarity/DataGain Category 6 Structured Cabling System and Corning Cable Systems LANscape solution
8. Legrand/Superior Essex nCompass Clarity/Category 6A Structured Cabling System with 10Gain+ reduced diameter cable and Corning Cable Systems LANscape solution (Access Solutions)

H. This specification is to ensure that UNCW meets with a standards compliant end-to-end cabling solution with guaranteed "Channel" performance. This solution will allow UNCW to maximize productivity and value by minimizing down time and operational expenses, thus warranting our investment for 20 Years, while still providing for a future path to evolving technologies. Each of these solutions requires the contractor to provide Manufacturer certification:

1. CommScope SYSTIMAX Category 6 and Category 6A solutions require the contractor to be a current PartnerPRO network member; installers, supervisors, designers to have a current valid certification.
2. CommScope NETCONNECT/Uniprise Category 6 and Category 6A solutions require contractor to be a current PartnerPRO network member; installers, supervisors, designers to have a current valid certification.
3. Belden solution requires the contractor to be a Belden Partner Alliance (PA) program member.
4. Legrand/Superior Essex solutions require the contractor to be a current Legrand Certified Installer Plus (CIP); installers, supervisors, designers to have a current valid certification.
5. Corning solution requires the installers to be a current EWP

2.2 PATCH CORDS

A. The qualified contractor will provide all patch cords for the project. The following criteria apply:

1. Patch cords are included in the project and provided by the voice/data contractor for the rack end and the work area outlet(s).
2. Patch cords must be manufactured by the selected end-to-end system manufacturer and must be of correct grade to maintain the beyond Category 6 or beyond Category 6A channel rating.
3. Installation of the patch cords will be by the contractor after review with Network communications.
4. Patch cords for the work area outlet will be 50 % 10 feet, and 50 % 5 feet. Unless otherwise designated by the Network communications department. The quantity for the Work area outlets will be for all Network communications data outlets throughout the facility.
5. Patch cords for each data cable in the data rack(s) of all communications rooms. At the rack end, the patch cords will be 100% 1 feet.
6. Category 6A patch cords provided by contractor for each wireless access point. The length is a minimum of 5 feet and the quantity is for each wireless access point. The patch cord for the rack end will be included in the data cable quantity.
7. Patch cords will be from one supplier and match the end-to-end solution installed for the project.
8. Patch cords submittals are included for review and include lengths and quantities.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to individual technical specification sections for detailed Cable Routing and Installation, Testing and Documentation requirements. The following apply to communications cabling and termination work.

B. Installation shall be per manufacturers' recommendations. All cable, equipment and hardware shall be arranged to provide a neat appearance and accessibility for servicing.

C. Label cables and termination components per Section 270553 - Communications Systems Identification.

3.2 CABLE INSTALLATION

A. Run cabling in raceways provided, or as designated on floor plans, and support from building structure.

1. Where installed in Cable Tray or along Cable Runways, lay cables neatly: Secure cable bundles using Velcro cable ties at 10-ft intervals.

2. NO ZIP TIES are allowed or any Plastic type cable ties that can be drawn tight and that are non-releasable shall not be permitted under any circumstance.
3. Installation of non-releasable plastic type cable ties on 4-pair station cables shall be removed and replaced with hook and loop type wraps at contractor expense with no delay in contract deadline.
4. Any damage or crimping of cables caused by installation of non-releasable fasteners of any material shall be reason for cable to be replaced, terminated and retested at contractor expense. Evaluation of cable damage shall be at sole discretion telecommunications engineer.
5. Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.
    a. Horizontal station cable: should have twelve inches of spare cable at the station outlet and 10 feet of spare at each rack
    b. Fiber terminating into the building: as per industry best practices, last 15 feet of fiber cable to be cut off and discarded after pulling, still leaving 20 feet of spare at each rack.
    c. Outside plant Category 3: Eight feet spare at each protector block.

B. Route and support cable in Equipment Rooms and Telecom Rooms utilizing "D-type" mounting rings and overhead cable runway.
    1. Non- releasable plastic type cable ties shall not be allowed on cable runways in Equipment Rooms.

C. Cable shall be free of tension at both ends.
    1. In cases where cable must bear stress, provide Kellems grips to spread stress over longer length of cable.

D. Provide required installation tools to facilitate cable pulling without damage to cable jacket.

E. Keep cables clear of other trades work.

F. During pulling operation provide an adequate number of workers to allow cable observation at points of raceway entry and exit, as well as to feed cable and operate pulling machinery.

G. Pull cables in accordance with cable manufacturer's recommendations and ANSI/IEEE C2 Standards.

H. Pull cable by hand unless installation conditions require mechanical assistance.

I. Do not exceed recommended pulling tensions and bending radii.
    1. Where mechanical assistance is used, ensure that maximum tensile load for cable is not exceeded.
        a. This may be in form of continuous monitoring of pulling tension, use of "break-away" or other approved method.
    2. Replace cables bent or kinked to radius less than recommended dimension.
        a. This shall be at no expense to Owner.

J. Install cables splice-free.

K. Avoid abrasion and other damage to cables during installation.
    1. Visually inspect cables for cuts, blisters and abrasions during installation.

L. Pulling lubricant may be used and shall:
    1. Be non-injurious to cable jacket and other materials used.
    2. Not harden or become adhesive with age.

M. Repair damage to interior spaces caused by installation of cable, raceway or other hardware. Repairs must match preexisting color and finish of walls, floors and ceilings.

N. Replace contractor-damaged ceiling tiles to match color, size, style and texture.

O. Provide pull cord (200 lb minimum) with cable installed in every conduit and innerduct.

P. Neatly lace, dress and support cabling.

Q. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.

1. Strap vertical runs as required, to prevent sagging of cables.

R. To reduce effects of EMI, adhere to the following minimum cable separation distances:

1. 8" from 120V, 208V or 277V power lines (2kVA or less)
2. 24" from high voltage lighting (including fluorescent)
3. 39" from power lines of 5 kVA or greater (any voltage)
4. 39" from transformers and motors

3.3 FIELD TESTING

A. Refer to Section 270000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performing compliance testing.

B. All 4-pair Category 6 cabling (either station or riser) shall have a maximum length of 90m (295 ft) and shall not exceed it.

1. Any cable exceeding the maximum length by more than 3% shall be replaced.
2. 3% excess is equal to less than 304 ft total length.
3. Any cable testing at 304 ft or above shall be replaced.
   a. Cable shall be replaced and retested at no additional cost to owner.
   b. Cable shall also be replaced even in the event that it passes all other design and performance parameters.
4. Excuse/explanation that cable twist is responsible for additional length over 304 ft shall be accompanied by a letter from manufacturer stating that their twist is responsible for additional length.
5. High pair-count voice copper backbone cabling shall not be held to same distance limitations as Cat 6 cabling.
   a. Any distance limitations for high pair count voice copper backbone cable shall be those imposed by manufacturer.

C. Cabling shall be 100% fault free. If any Link is found to be outside specification defined herein, identify and correct problem up to and including replacement of cable and associated termination(s). Then repeat applicable tests.

D. Test each cabling sub-system (e.g. backbone, horizontal, etc.) end-to-end.

E. Where sub-systems are to be interconnected or cross-connected by the contractor, test individual sub-system followed by a test of the connected links

1. Performance and documentation requirements shall default to the lesser of the two connected systems if different.

2. Example 1: Combined Backbone-Horizontal Link
    a. Test and document individual Backbone and Horizontal Cabling Sub-systems.
    b. Cross-connect sub-systems.
    c. Repeat testing on combined cabling from MC - TO, through HC.
    d. Performance and documentation requirements shall be based in this example on backbone cabling (continuity, pair integrity, etc.).
3. Example 2: Interconnected Zone Cabling Link
    a. Test and document individual HC – CP links.
    b. Install interconnect cabling CP - TO
    c. Repeat testing on combined cabling from HC - TO through CP.
    d. Performance and documentation requirements shall be based in this example on TIA Permanent Link for Horizontal Cabling.

F. Test instrument shall be configured using template for exact cable under test (e.g. by manufacturer product designation).
1. If no template is available, enter cable parameters for the cable per manufacturer's product data.
    a. Nominal Velocity of Propagation (NVP) used for copper cable type under test shall be traceable to manufacturers' product data.
    b. Refractive Index used for fiber optic cable type under test shall be traceable to manufacturers' product data.
2. Test results obtained using incorrect cable parameters will be rejected.

G. Refer to individual Technical Sections for system-specific guidelines regarding requirements for scheduling and performing compliance testing.

3.4 DOCUMENTATION

A. Refer to Section 270000 - General Communications Requirements for general guidelines regarding requirements for project Documentation.

B. Refer to individual Technical Sections for system-specific guidelines regarding requirements for project Documentation.

3.5 OWNER TRAINING

A. Provide training for Owner's personnel on operation and maintenance of total system and each component.

B. Training to include:
1. Overview of System Topology and General Concepts
2. Overview of Product Used
3. Overview of Equipment Room Layouts
4. Overview of Labeling Formats
5. Overview of Test Results and their meaning
6. Overview of Documentation

C. Training shall be held at Project Site and shall be conducted during normal working hours.

D. Training session duration shall be not less than one (1) hour.

1. Provide 2 such sessions.
2. Coordinate with owner to schedule session(s). Provide adequate notification to allow owner to schedule staff.

E. Attendance shall be by owner staff and/or contract maintenance personnel.

1. Number of Students per session shall be 6.
2. Materials shall be provided for the number of students indicated.

F. Provide example course materials and instructor background in advance of training session(s).

G. Owner may videotape session(s) for use as future refresher materials for owner technical staff.

END OF SECTION 271000

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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 SCOPE

A. This section details product and execution requirements for Communications Equipment Room Fittings for Communications Systems.

B. Install MDF/IDF rooms per the design documents and to UNCW ITS standards. Telecom Room placement shall limit the installed cable distances to a maximum of 90 meters.

1.3 DESCRIPTION

A. Communications Room/Equipment Room

1. The ER/TR(s) for each building provide for a transition between the horizontal and backbone pathways and provide space for Network communications components including cable terminations (horizontal and backbone), active and passive equipment, cross-connections cabling, and hardware, and any other materials or equipment associated with the building Network communications, data and technology systems. All Communications Rooms shall have direct access to the hallway or other such corridor. Network communications rooms are dedicated space. Building services such as Electrical (i.e. Electrical Distribution Panels or Transformers) poses a threat of damage or EMI interference that makes them completely unacceptable for Network Communications Equipment and wiring. Supporting codes are in the TIA-568B-C and TIA-569 wiring standard unequivocally against Multi-Use Communications rooms. In existing buildings, due to age of the building and design criteria at that, time space shared with other trades exists until the building's renovation or space is available.
2. Network communications doors should not open into network communications Rooms.
3. Network communications Rooms shall not contain any type of sink or storage for Custodial or any other such supplies.
4. Network rooms MDFs, IDFs: - do not allow storage of any kind (i.e. Books, Furniture, A/C Filters, Light Bulbs, AV Equip. etc….).
5. All Network Communications locations shall be equipped with a grounding bus bar. A solid copper grounding bus bar ¼-inch thick x4 inches high with compression fittings and standoff brackets with insulators will be required on the Network communications backboard.
6. Fire Alarm panel installation in the TR or the ER not permitted.
7. Electrical outlets mounted at eighty-two (82) inches above AFF to top of outlet.
8. All electrical outlets are on the emergency generator. If the building does not have an emergency generator circuit prepping for future installed is required.
9. Installation of electrical conduits, refrigerant pipes, water pipes, HVAC ducting or piping, elevator alarms or pump alarms cannot penetrate through the communication or ER rooms.
10. Dedicated duplex 20 amp 110 VAC outlets on separate circuits are required. Convenience outlet mounting is at six foot. Intervals around the perimeter.
11. One- L6-20P outlet is required. Outlet is mounted at eight-two (82) inches AFF.
12. To improve visibility all walls are white in color.
13. HVAC: 24 hours/day, 365 days a year, 64 degrees to 75 degrees Fahrenheit, 30 to 55% humidity, positive pressure.
14. Lighting: Typically, 8.5 ft. high providing 50 ft. candles @ three feet above the floor.

15. Dust: less than 100 micrograms/cubic meter/24-hour period.
16. Audio Visual (AV) Cabling: AV cabling shall not use the communications rooms: MDF, IDF, and Entrance Facility as a pathway due to legal and auditing problems. The AV cable for riser pathways needs its own dedicated pathway. AV equipment storage is not allowed.
17. Intercom units: The single data line for each intercom unit is a standard data cable and terminate in the communications room data rack. Network Communications maintain the cable. AV maintains the power supply and must be located in a dedicated area separate from the communications rooms.
18. Sleeves and Pathways for Communications, data, and fiber optic cabling is dedicated and not to be used by other trades. Each trade is responsible for providing a dedicated pathway that meets code. Ty-wrapping or attaching to communications pathways or supports is not allowed.
19. Racks are two post open frame with three (3) inch deep channel, seven (7) feet in height, nineteen (19) inches wide and have a total of forty-five (45) RU's. Vertical cable management will be a minimum of six (6) inches wide and six (6) inches deep, double sided with covers. Each rack will have a vertical cable manager per side. If two (2) racks are side by side the total Vertical cable manager's width will be twelve (12) inches wide.

B. Communications Equipment Room Fittings include:

1. Cabinets, Racks, Frames and Enclosures
2. Cable Runway
3. Termination Blocks
4. Patch Panels
5. Entrance Protection
6. Power Strip/Surge Suppressor
7. Grounding Bar
8. Dedicated Power

C. Refer to Project Drawings for Equipment Room layout and equipment placement.

D. 3/4" Plywood shall be installed on all walls from the floor to 8'-4" AFF and painted white with fire-rated stamp taped off for building inspector approval. Plywood shall be attached to the walls utilizing flush mounted hardware. Mount 4" AFF.

E. TR room door shall open out into corridor/room. The door shall have a door lock installed.

F. Telecom room will be cooled 24/365, refer to Mechanical plans and specifications for further details.

G. Telecom room shall be serviced with (1) L6-20R-amp dedicated electrical circuit mounted above each rack at 82 inches. In addition to the above rack power each wall shall be fitted with a flush mounted, double gang, 110 volt, 20amp mounted at 82" every 6' around the room. Refer to the electrical drawings for the branch electrical circuits and exact location of power serving the TR.

H. Contractor shall provide one power strip/surge protector with a minimum 15'-0" cord for each installed rack. These strips shall be delivered directly to the project manager. Six foot vertical mounted with standoff brackets.

I. All Network Communications locations shall be equipped with a grounding bus bar. A solid copper grounding bus bar ¼-inch thick x 4 inches high with compression fittings and standoff brackets with insulators will be required on the Network communications backboard.

J. Bus bar connection is to a backbone of insulated, solid copper (minimum #6 AWG, with 3/0 recommended). This backbone is to the main grounding bus bar in the electrical entrance facility that bonds back to the building's grounding system. This point should be at an electric panel per NEC standards. Chatsworth grounding bar 10622-010 or equivalent. The grounding bar location is mounted above the horizontal cable tray in the TR.

K. Contractor shall provide and install fire sprinkler pipes per applicable code requirements. Where sprinkler heads are installed, install wire sprinkler cages. Floor drainage troughs shall be installed. Refer to the Fire protection and Plumbing drawings and specifications for exact telecom room design.

L. Related Division 27 Sections include:

1. Section 270000 - General Communications Requirements
2. Section 270526 - Grounding and Bonding for Communications Systems
3. Section 270528.29 - Hangers and Supports for Communications Systems
4. Section 270528.33 - Raceway and Boxes for Communications Systems
5. Section 270528.36 - Cable Tray for Communications Systems
6. Section 270553 - Communications Systems Identification
7. Section 271000 - Structured Cabling
8. Section 271300 - Communications Backbone Cabling
9. Section 271500 - Communications Horizontal Cabling

1.4 DEFINITIONS

A. Refer to Section 270000 -General Communications Requirements and Section 271000 - Structured Cabling which provide information on Definitions used in this and related sections.

1.5 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 270000 -General Communications Requirements and Section 271000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related sections.

1.6 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

1.7 QUALITY ASSURANCE

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.8 GUARANTEE

A. Refer to Division 1, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 271000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to cable and components covered in this section.

PART 2 - PRODUCTS

2.1 EQUIPMENT CABINETS

A. Refer to the Telecom plans for the exact layout and quantity of the racks in the room. Prior to install the room layout shall be reviewed and approved with the UNCW ITS

B. Free Standing Equipment Rack shall comply with general requirements above and shall:

1. Be 84" in height
2. Have minimum of 45 usable rack mounting units (RU).
3. Be self-supporting.
4. Have Minimum base footprint of 15" x 20".
5. Be double-sided drilled and tapped to accept 12-24 screws.
6. Uprights shall be drilled on back to accept cable brackets, clamps, power strip(s).
7. Hole pattern on rack front and back shall be per EIA/TIA specifications (5/8" - 5/8" - 1/2").

2.2 Vertical Cable Management shall:

A. Be minimum 6” wide and 6” deep, 7’-0” tall, double sided with covers, with black finish and

B. “D” rings approximately 8” on center

1. Provide for cable routing on front and rear of each rack,
2. Be 6” wide (minimum) when installed between two racks (refer to IDF Enlarged Plans).
3. Be 6” wide when installed at end of rack row.
4. Incorporate cable slack spools.
5. Mount on spacers attached to rack uprights and not on upright.
6. Be accessible from front and rear of rack.
7. Be designed to space slots/fingers at 1 RU intervals to align with rack-mounted equipment.

C. Equipment Rack Ground Strip

1. Material: Copper
2. Mounts horizontally in rack
3. Mounting configuration EIA universal mounting hole pattern, tapped #12-24.

D. Miscellaneous

1. Contractor shall only use black Velcro straps for all cabling
2. Absolutely NO Zip ties are allowed for any low voltage cable supports

2.3 CABLE RUNWAY

A. Approved Manufacturer: B-Line CPI, Siemon, Cablofil

B. Cable Runway shall:

1. Be constructed of 0.065" thick steel
2. Utilize tubular stringers to support rungs.
   a. Stringers shall be 1-1/2" high.
   b. Rungs shall be welded to stringers and shall be spaced 9" on center.
3. Be painted with black epoxy.

C. Runway width shall be 18”, unless shown otherwise on drawings.

D. Shall be mounted at 7’-2” to bottom of cable runway to prevent interference with door or as shown on Enlarged Plans.

2.4 MODULAR PATCH PANELS:

A. Provide 48 port Cat 6A patch panels for termination of Cat 6A WAP cable only.

B. Patch panels are to be mounted in 7’-0” floor racks dedicated to horizontal/station cabling.

C. Modular Jacks in Panel shall:

1. Be non-keyed, 8 position, 8-conductor (8P8C),
2. Be wired per TIA T568-B pinning standard.

D. Panels shall meet or exceed TIA Category 6A performance criteria

1. Shall be matched to cabling to support additional headroom.

2.5 FIBER OPTIC PATCH PANELS

A. Patch Panels shall:

1. Be installed at the MDF and IDF’s
2. Blank Covers for unused coupling assembly spaces in panels.
3. Assembly spaces shall be utilized in consecutive order without skipping module spaces
4. Be enclosed assemblies
5. Shall incorporate hinged or retractable front covers designed to protect.
6. Mounted in 19” racks

B. Couplings shall be mounted on assembly that snaps into patch panel enclosure.

1. This assembly shall be designed to accept variety of coupler types including, LC, ST, SC, duplex SC and high-density mini-connectors.
2. Coupling type shall be LC
3. Coupling Color shall be as follows:

a. Multimode: BLACK

1) Exception: LASER-optimized 50/125 Multimode couplings shall be AQUA

b. Single-mode: BLUE

C. Access to inside of panel enclosure during installation shall be from front and rear.

1. Panels that require disassembly of cabinet to gain entry will not be accepted.

D. Incoming cables shall not be accessible from patching area of panel.

1. Enclosure shall provide physical barrier to access of such cables.
2. Where factory-terminated cable assemblies ("pigtails") are spliced to cable, enclosure shall incorporate hardware for securing of splice tray and required cable, buffer tube and pigtail slack.

2.6 ENTRANCE PROTECTION

A. Manufacturers: Corning, Porta Systems, CommScope, Circa

B. Interface on Protection devices shall be as follows:

1. Input: 110-type block
2. Output: 110-type block

C. Entrance protection shall:

1. Be listed primary protector
2. Accommodate industry standard 5 pin protection modules
3. Be provided with grounding lug

D. Covers on protector housing are required as follows:

1. On input side
2. On output side

E. Protection modules shall:

1. Be Solid-State type
2. Have nominal DC Breakdown voltage of 75 Volts.
3. Be self-resetting
4. Provide effective protection against "sneak current" events
5. Have fail-safe design to protect personnel and equipment from exposure to sustained high voltages and currents

2.7 POWER STRIP/SURGE SUPPRESSOR

A. Manufacturers: CPI, Hubbell, Ortronics, Wiremold, Pulizzi Engineering, APC

B. Power Strip/Surge Suppressor shall:

1. Be rack mountable in 19" equipment racks vertically
2. Provide Transient suppression to 13,000 A
   a. Protection shall be in 3 modes (hot-neutral, hot-ground and neutral-ground)
3. Provide High Frequency Noise Suppression:
   a. >20-dB @ 50-kHz
   b. >40-dB @ 150-kHz
   c. >80-dB @ 1-MHZ
   d. >30-dB @ 6 to 1000 MHZ
4. Provide minimum of 320 Joules of AC energy absorption
5. Be equipped with minimum 12 ft power cord
6. Be rated for 1 phase, 20A load at 208/120V

C. Vertically mounted power strips / suppressors shall be equipped with minimum 10 receptacles.

1. Power strips / Suppressor shall be maximum 48" long.
2. Power strips shall have the ability to provide the following power configurations:
   a. 1 phase, 120 V
   b. 1 phase, 208 V

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to project Drawings for communications equipment room layout and equipment placement.

B. New communications equipment rooms must be free from dust, dirt, and other foreign materials before installation of any termination hardware or termination of copper or fiber optic cables.

1. Door to room must be closed during termination if area outside room is not dust-free.

C. Communications cabinets, racks, frames and enclosures shall be grounded and bonded.

D. All cabinets, racks, frames, and enclosures shall be installed according to manufacturer's recommendations, including secure mounting to the floor or other structure as appropriate Provide necessary assistance to allow Owner or Carrier personnel to establish service on new cable system.

1. Includes general wiring overview, cable pair identification, and cross connect documentation (if applicable).

3.2 EQUIPMENT RACKS AND CABLE MANAGEMENT

A. Owner Preferred: Chatsworth

B. Other approved Manufacturers: Great Lakes, Cooper B-Line, Commscope

C. Provide equipment racks as shown on project Drawings.

D. Racks shall be standard Racks are two post open frame with three (3) inch deep channel, seven (7) feet in height, nineteen (19) inches wide and have a total of forty-five (45) RU's.

E. Each rack will have a vertical cable manager per side. If two (2) racks are side by side the total Vertical cable manager's width will be twelve (12) inches wide.

F. Racks shall be constructed of aluminum.

G. Channel uprights shall be spaced to accommodate industry standard 19" mounting.

H. Each rack shall be supplied with spare screws.

I. Each rack shall be 84" in height and shall be self-supporting.

J. Each rack shall be double-side drilled and tapped to accept 12-24 screws.

K. Uprights shall be drilled on the back to accept cable brackets, clamps, power strip(s), etc.

3.3 CABLE RUNWAY

A. Provide cable runway and accessories necessary for complete system.

B. Size and layout of cable runway shall be as shown on project Drawings.

C. Install bottom of cable runway at 7'-2" above finished floor.

D. Align with equipment racks as follows:

1. Where parallel to rack row, align center of runway with center of rack.
2. Where at right-angle to rack, align center of runway with center of rack.

E. Brace to racks with support brackets made by runway or rack manufacturer intended for this purpose.

F. Use radius drops where cables drop from tray to rack and at elevation changes of 6" or more.

G. Maximum allowable deviation of runway from level horizontal plane measured across length of cable runway shall be 1/2", with tray loaded to capacity.

H. Where cable runway is supported from building structure:

1. Provide 3/8" threaded rods for support of 12" wide or smaller runway.
2. Provide 1/2" threaded rods for support of runway greater than 12" in width.

I. Bond runway components together using manufacturer's standard accessories.

J. Fasten cables to runway at intervals not to exceed 4 ft.

3.4 TERMINATION BLOCKS

A. Provide blocks to accommodate an additional 20% growth at each location.

B. Terminate Backbone Voice Cables on termination blocks.

1. Strip lengths & termination of all cabling to be per manufacturers recommendations.

C. Provide 110 blocks as follows:

D. All horizontal cables will terminate on information outlets in a 24 port (first 24 cables) and then 48 port patch panels.

3.5 MODULAR PATCH PANELS

A. Provide panels to accommodate an additional 20% growth at each location.

B. Mount patch panels in 19" equipment racks.

C. Provide minimum of 4 screws to secure each patch panel onto rack.

D. Bond F/UTP cable shield and drain wire to connecting hardware per manufacturer’s instructions. Bond connecting hardware to the Telecommunications grounding system.

3.6 FIBER OPTIC PATCH PANELS

A. Provide Fiber Optic Patch Panels and coupling assemblies at horizontal and main cross-connect locations.

1. Provide minimum of 4 screws to secure each patch panel onto rack.

B. Provide couplings in coupling assemblies and mount coupling assemblies and blank covers in patch panels.

C. Position fibers consecutively - starting with lowest number - and mapped "position for position" between patch panels.

1. There shall be no transpositions in cabling.

D. Keyways on duplex couplings shall be oriented to establish "cross-over" in cabling system.

1. Convention defined by TIA/EIA-568-B.1 (Section 10.3.2 "Connecting Hardware Termination and Polarity") shall be used.
2. Reverse-pair positioning shall not be used.

E. Provide blank covers for unused coupling assembly spaces in panels.

F. Clean couplings with foam swab and isopropyl alcohol prior to connector insertion. Blow dry with compressed air.

G. Provide dust caps for couplings.

3.7 ENTRANCE PROTECTION

A. Provide protector at each end on inter-building backbone copper pairs.

1. Position protector as close as possible to building entrance.

B. Install per manufacturers recommendations.

C. Ground protector assemblies to Telecommunications Grounding Busbar via #6 AWG (minimum) conductors.

D. Provide Protector Modules for 100% pairs terminated.

E. If special tool is required to open protector housing, provide 2 such tools to Owner at completion of work.

3.8 POWER STRIP/SURGE SUPPRESSOR

A. Provide (1) 20A power strip/surge suppressor in each rack.

3.9 FIELD TESTING

A. General

1. Refer to Section 270000 - General Communications Requirements and 271000 – Structured Cabling for guidelines regarding documentation requirements.
2. Refer to referenced technical sections for detailed requirements to testing of each cable sub-system.

3.10 DOCUMENTATION

A. General

1. Refer to Sections 270000 - General Communications Requirements and 271000 – Structured Cabling for guidelines regarding documentation requirements.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

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 SCOPE

A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.3 DESCRIPTION

A. Backbone cabling subsystem is portion of communication link that connects campus outside plant services to intermediate cross-connect (typically at Telecom Room).

B. Cabling shall be neatly laced, dressed and supported. Work not done to the satisfaction of the UNCW ITS Telecommunications office and the designer will be reworked at no cost to the Owner.

1.4 RELATED WORK

A. Related Division 27 Sections include:

1. Section 270000 - General Communications Requirements
2. Section 270526 - Grounding and Bonding for Communications Systems
3. Section 270528.29 - Hangers and Supports for Communications Systems
4. Section 270528.33 - Raceway and Boxes for Communications Systems
5. Section 270528.36 - Cable Tray for Communications Systems
6. Section 270553 - Communications Systems Identification
7. Section 271000 - Structured Cabling
8. Section 271100 - Communications Equipment Room Fittings
9. Section 271500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. See individual technical sections identified above (if applicable).

1.5 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

1.6 QUALITY ASSURANCE

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.7 GUARANTEE

A. Refer to Division 1, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 271000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA/EIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Backbone cable types include:

1. Copper Twisted Pair
2. Fiber Optic

2.2 TWISTED PAIR CABLING

A. General:

1. Manufacturers: Same as specified for horizontal cabling in Section 271500.
2. Cabling shall:

a. Be constructed of individually twisted pairs.
b. Be suitable for installation in environment defined.
c. Be packaged to minimize tangling and kinking of cable during installation.

3. Cables of 25 pair and up are 24 AWG, LSPR Power Sum (Category 5e) solid conductor cables. These high pair-count cables terminate on 110-style 360 pair for the SYSTIMAX system, the Belden termination solution or the NECTONNECT Category 5e solution. The punch-down order is the traditional USOC color code order for Multi-pair telephone cables Punched on patch panels and information outlets with insulation displacement connectors installed. All terminations will be on a 24-port patch panel. 1 pair per information outlet.
4. Riser copper voice cables are one (1) 25 pair power sum cat 5E cable from the MDF to each IDF

2.3 FIBER OPTIC CABLE

A. General

1. Fibers utilized in installed cable shall be traceable to manufacturer.
2. The backbone fiber feeding the building is 96-strand single mode with LC connectors and 24-port interconnect panels. Corning Cable Systems LANscape solution. Refer to Package A.

3. The fiber-optic cables used between the MDF and each IDF will be a cable consisting of 48 single-mode fibers. The number and type of fiber and quantities required are according to the existing and future network requirements. Corning Cable Systems fiber optic cable and terminated with LC connectors mounted in Corning Cable Systems LANscape rack-mounted hardware in the top position of the data rack. All 48-strand fibers must terminate in 24-port interconnect panels. Fiber terminations for the rack end will be LC-pigtail fusion spliced.

B. Optical Fiber - General

1. Optical fibers shall:

a. Be sufficiently free of surface imperfections and occlusions to meet optical, mechanical, and environmental requirements of this specification.
b. Have been subjected to minimum tensile proof test by fiber manufacturer equivalent to 100-kpsi.

2. Factory optical fiber splices are not allowed.
3. Coatings shall be mechanically strippable without damaging optical fiber.

C. Single-mode Optical Fibers:

1. Single-mode Optical Fibers:
2. Fiber Type: Single-mode
3. Strand Count: as shown on Drawings
4. Transmission Windows: 1310 nm, 1550 nm
5. Core Diameter: 8.3 microns
6. Cladding Diameter: 125 microns ± 1 micron
7. Coating Diameter: 245 microns ± 10 microns
8. Maximum Attenuation:

a. 1310 nm: 0.5 dB/km (at 23° ± 5°C)
b. 1550 nm: 0.4-dB/km (at 23° ± 5°C)
c. When tested in accordance with FOTP 3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical cable, and Other Passive Fiber Optic Components", average change in attenuation over rated temperature range of cable shall not exceed 0.05 dB/km at 1550 nm. Maximum attenuation change shall not exceed 0.15 dB/km at 1550 nm.

D. Indoor Backbone Fiber Optic Cable

1. Cable shall:

a. Be suitable for installation in free air, in building risers, in conduit, in cable tray and in innerduct.
b. Be dielectric materials (no conductive materials).

2. Cable shall meet the following specifications:

a. Jacket Material: FEP or equivalent as required for cable rating
b. Buffer Diameter: 900 microns (tight buffer)
c. Jacket Color

1) Multimode: ORANGE

a) Exception: LASER-optimized 50/125 Multimode: AQUA

2) Single-mode: YELLOW

d. Cable Rating: OFNR
e. Strength Member: Aramid Yarn
f. Storage Temperature: -40° to +70°C (no irreversible change in attenuation)
g. Operating Temperature: -20° to +70°C (no irreversible change in attenuation)

h. Humidity Range: 0 to 100%
i. Maximum Tensile Strength:

1) During Installation - 2700 N (no irreversible change in attenuation)
2) Long Term - 1000 N

j. Bending Radius:

1) During Installation - 20 times cable diameter
2) No Load - 10 times cable diameter

2.4 FIBER OPTIC CONNECTORS

A. Connectors shall:

1. Be LC-type.
2. Sustain minimum of 200 mating cycles.

B. Connector ferrule shall be ceramic or glass-in-ceramic.

C. Connectors shall meet the following performance criteria:

Test Procedure	Max. Attenuation Change
1. Cable Retention (FOTP-6)	0.2 dB
2. Durability (FOTP-21)	0.2 dB
3. Impact (FOTP-2)	0.2 dB
4. Thermal Shock (FOTP-3)	0.2 dB
5. Humidity (FOTP-5)	0.2 dB

D. Optical fiber shall:

1. be LC-Pigtail fusion spliced at the rack end

E. Attenuation per connector shall not exceed 0.5 dB.

F. Reflectance (maximum) when mated with patch-cord made up of connectors of comparable design shall be as follows:

1. Multimode: -20 dB
2. Single-mode: -40 dB

PART 3 - EXECUTION

3.1 CABLE INSTALLATION AND TERMINATION

A. General

1. Provide cables as shown on Project Documents and herein
2. Size cables as shown on Project Documents.
3. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling for general cable installation requirements.

B. Backbone UTP Cable:

1. Terminate cables on 24-port backbone patch panels

   a. Maintain cables pair twists to within 1" of termination.
   b. Remove cable jacket only to extent required to make terminations.

C. Fiber Optic Cable

1. Route backbone fiber optic cable in innerduct.
2. Ground any metallic cable elements (if applicable) per Code.
3. Terminate fiber strands on Fiber Optic Connectors mated to couplings mounted in Fiber Optic Patch Panels.

   a. Terminate all fibers.

4. Follow manufacturer's guidelines for connector type(s) provided.

   a. Clean connectors with lint-free pad saturated with 90% to 100% isopropyl alcohol after fiber termination. Wipe with dry, lint-free pad and blow end face with compressed air for minimum of 5 seconds.

5. Fibers with coatings <900 microns shall be furcated (fanned-out) to minimum of 900 microns before termination.

   a. Provide buffer tube fan-out kits for fibers terminated in patch panel couplings.

6. Provide cable slack in each backbone fiber optic cable.

   a. Slack shall be in addition to length of fiber required for termination requirements.
   b. Store cable slack in enclosure designed for this purpose.
   c. Slack required shall be as follows:

      1) Backbone Intra-Building: Minimum of 5 meters (each cable if applicable) coiled and secured at one end (preferably at Telecom Room).
      2) Backbone Inter-Building: Minimum of 15 meters (each cable if applicable) coiled and secured at one end (preferably at Equipment Room).
      3) Maintenance Holes/Manholes: Minimum of 1-1/2 times inside dimension of Maintenance Hole/Manhole.

7. Backbone fiber will terminate in each MDF and TR in a data rack fiber patch panel, Corning Cable Systems LANScape or Belden Enterprise X (ECX) optical fiber patch panels
8. The cable termination is with LC connectors and rack-mounted hardware.

3.2 FIELD TESTING

A. General

1. Refer to Section 270000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performance of compliance testing.

   a. Contractor shall be responsible for testing each system end-to-end.

B. Backbone UTP Cable Testing

1. Same as Horizontal UTP Testing (Refer to 271500)

C. Backbone Fiber Optic Cable Testing

1. Pre-Installation Testing

   a. Pre-installation testing shall be done at contractor option.

b. Submit cable manufacturer's test report for each reel of cable provided.

1) Verify fiber attenuation, bandwidth and length values as specified on cable data sheets supplied with cable reels.

c. Visually inspect reels and packaging for damage.

2. Post-Installation Testing

a. Testing shall include:

1) Optical Attenuation
2) Optical Time Domain Reflectometry (OTDR)
3) Optical Return Loss

b. Optical Attenuation

1) Light Source: LED
2) Measure Optical Attenuation on terminated fibers.

a) Include optical connectors and couplings installed at fiber endpoints.

3) Test multimode fibers using EIA/TIA 526-14A, Method B.
4) Test single-mode fibers using EIA/TIA 526-7-1998. Method A.1.
5) Test all fibers in both transmission directions.
6) Test multimode fibers at 850 ± 30 nm and 1300 ± 20 nm wavelengths.
7) Test single-mode fibers at 1310 ± 10 nm and 1550 ± 10 nm wavelengths.
8) Fiber lengths less than or equal to 300 ft shall test to U<U 2.0 dB loss.
9) Fiber lengths greater than 300 feet shall test to loss value less than link loss budget for installed connectors and fibers.

c. Optical Time Domain Reflectometry (OTDR)

1) Verify integrity of all fibers - using an Optical Time Domain Reflectometer (OTDR).

a) Includes terminated and (if applicable) un-terminated fibers.

2) OTDR(s) shall incorporate high-resolution optics and short pulse-width options optimized for viewing of short cable sections.

a) Pulse-width shall be 10-ns or less.

3) OTDR traces shall be performed in one direction using access jumpers at transmit and receive ends.

a) Minimum length of access jumper at launch end shall be minimum 100 meters long for multimode or 300-meters long for single-mode, unless recommended otherwise by test equipment manufacturer.

4) Test multimode fibers at 850 ± 30 nm wavelength.
5) Test single-mode fibers at 1310 ± 10 nm wavelengths.
6) Examine traces for continuity and anomalies to confirm fiber link integrity.

a) Point discontinuities in excess of 0.2 dB for multimode fibers or 0.1 dB for single-mode fibers shall be cause for rejection of cable.
b) Any reflection in trace - except at patch panels - shall be cause for rejection of cable.

7) OTDR tested links showing excessive backscatter immediately following connector shall have connector cleaned and/or re-polished and then retested.

d. Optical Return Loss

1) Testing shall include Optical Return Loss (ORL) measurement for each installed single mode fiber optic connector. Follow OTDR manufacturer's requirements for required tester settings, including scattering coefficient.
2) Perform ORL with a Back Reflection Meter or an OTDR.

a) OTDR shall be capable of measuring fiber connector reflectance and produce accurate (± 2 dB) reflectance measurements

3) Test result cursors shall be placed at appropriate locations before tests are submitted for review. OTDR testers including automatic cursor positioning functions shall use said functions to position cursors accurately for measurement.

3.3 DOCUMENTATION

A. General

1. Refer to Section 270000 - General Communications Requirements for general guidelines regarding documentation requirements.

B. Backbone Copper Cable

1. Document cross-connects between backbone, and horizontal or tie cabling.

a. Documentation shall be in the form of a spreadsheet which relates backbone pair count with horizontal cable or tie cable information. Base horizontal cable information on outlet designation and pair count.

C. Backbone Fiber Optic Cable

1. Files containing Attenuation and OTDR traces of individual optical fiber "signatures" shall be so named as to identify each individual fiber by location in cable system and fiber number or color.
2. OTDR test results shall be consistent in format and presentation, including:

a. Scale

1) Scale or window of test result view shall show only enough trace to view fiber under test plus launch cords at both ends.
2) View shall not show backscatter beyond end of fiber.

b. Pulse width
c. Units (English or Metric)
d. Cursor placement
e. Labeling

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

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 SCOPE

A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.3 DESCRIPTION

A. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at Telecom Room) and Telecommunications Outlet.

B. Horizontal cable for voice and data shall be Category 6 UTP. WAP cables are Category 6A.

C. Cabling shall be neatly laced, dressed and supported. Work not done to the satisfaction of the UNCW ITS Telecommunications office and the designer will be reworked at no cost to the Owner.

1.4 RELATED WORK

A. Section 270000 - General Communications Requirements

B. Section 270526 - Grounding and Bonding for Communications Systems

C. Section 270528.29 - Hangers and Supports for Communications Systems

D. Section 270528.33 - Raceway and Boxes for Communications Systems

E. Section 270528.36 - Cable Tray for Communications Systems

F. Section 270553 - Communications Systems Identification

G. Section 271000 - Structured Cabling

H. Section 271100 - Communications Equipment Room Fittings

I. Section 271300 - Communications Backbone Cabling.

1.5 REFERENCES AND STANDARDS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which identifies pertinent References and Standards.

1.6 DEFINITIONS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide information on Definitions used in this and related Sections.

B. In this section, "Telecommunications Outlet" is considered to consist of Frame / Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blanks fitted to unused jack positions, and labeling/identification components.

1.7 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide information on Abbreviations and Acronyms used in this and related Sections.

1.8 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:

1. Samples of each Telecommunications Outlet Faceplate type to confirm color and material.
2. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
   a. Section shall have manufacturer's cable markings visible.
3. Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.9 QUALITY ASSURANCE

A. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 1, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 271000 - Structured Cabling for particular warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Cables and Termination hardware shall be of the same manufacturer, or manufacturing partner, incorporate a total system approach and be technically compliant with and installed in accordance with referenced TIA/EIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Work Area Outlet to Patch Panel) are specified to function as System.

1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

D. Horizontal Cable types include:

1. 4-pair Copper Unshielded Twisted Pair (UTP)

E. 4-Pair Horizontal Copper Cables and Modular Jacks are application dependent as detailed below.

2.2 4-PAIR HORIZONTAL COPPER CABLE

A. Manufacturers: Refer to Division 27, Section 271000

B. All cables shall be suitable for installation in environment defined. All cables installed under Div 271500 shall be UL Listed as plenum-rated cable unless it is fully installed in conduit. No constructions that use mixed insulation materials will be allowed.

C. Maximum diameter of cabling shall be .300 inches.

D. Cabling shall be packaged to minimize tangling and kinking of cable during installation.

E. Any twisted 4-pair cable submitted as CAT 6/6A shall meet minimum TIA published frequency requirements for Category 6/6A.

2.3 CABLING

A. Configuration:

1. Number of Pairs: 4 twisted pair

a. Pair twists of any pair shall not be same as any other pair.
b. Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA/EIA 568-B.2.

2. Conductors: insulated solid annealed copper pairs

a. Category 6/6A: 24 AWG
b. Any copper alloy shall not be accepted
c. Any copper covered metal shall not be accepted

3. Drain Wire: Per manufacturer
4. Cable Rating: Plenum rated where routed through a ceiling cavity unless installed in conduit. Riser-rated, when installed in conduit. NEC Article 800 Type CMR, UL listed

B. Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.

1. By pair number, pair colors or dominant band are:

a. Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
b. Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
c. Pair 3: Tip - White/Green; Ring - Green (or Green/White)
d. Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

C. Horizontal Data Cable:

1. Shall meet or exceed Category 6 performance requirements.
2. Have a Blue Jacket
3. Each cable for wireless access points (WAPs) shall be a "Beyond" Category 6A cable rated to a minimum of 500 MHz. Each cable for WAPs shall be third party verified to comply with or exceed Category 6A requirements and shall carry be capable of supporting 100W Power-Over-Ethernet over 100 meters. Cable color shall be Purple.

D. Horizontal Voice Cable:

1. Shall meet or exceed Category 6 performance requirements.
2. Have a White Jacket

E. Horizontal CATV Cable:

1. Shall be routed back to the Telecom Room, patched and terminated at the top of third rack. Terminate on wall besides CATV feeder.

F. Horizontal Cable for Wireless Access Points

1. Shall meet or exceed performance requirements of Category 6A.
2. Have a Purple Jacket.

2.4 HORIZONTAL FIBER OPTIC CABLE

A. Fiber Optic Cable

1. Cable shall:

a. Incorporate 2 tight-buffered fiber strands in single jacket.
b. Incorporate duplex design with 1 tight buffered fiber strand in each jacket.
c. Allow direct terminations on specified fiber optic connectors.
d. Installed in either conduit or innerduct. Armored fiber optic cable is acceptable.

2.5 TELECOMMUNICATIONS OUTLET

A. Connectors (modular jacks, fiber optic couplings) shall snap onto faceplate.

1. In surface-mount designs (if applicable) Jacks and connectors may mount to frame onto which coverplate is mounted.
2. Any unused jack/connector positions shall be fitted with a blank of stainless steel faceplate.

B. Work Area Faceplate

1. Wall-mounted faceplates intended to be used in general work areas shall:

a. Be configured to mount on standard, single gang opening (mud-ring) mounted to double-gang box when wall mounted.
b. Accommodate minimum of 4 modular jacks and connectors.
c. Be constructed of high impact, UV resistant plastic white faceplate
d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.

1) Triple row faceplates with no provisions for labeling of middle outlet row are not acceptable.
2) Designation strips shall be fitted with clear plastic covers.
3) Designation strips and covers shall be positioned over faceplate mounting screws.

e. Faceplate Color: Communications Office White

C. Wall-mount Telephone Faceplate

1. Faceplates intended to be used in locations where wall mounted telephone set is required shall:

a. Be high impact, UV resistant plastic white faceplate
b. Accommodate 1 modular jack meeting performance requirements for "Voice" jack as defined above.

1) Modular jack shall be positioned to mate with wall-mounted telephone.

c. Mount on standard single gang opening.
d. Include mating lugs for mounting wall-mounted telephone.

D. Faceplate - Wireless Access Point Location

1. Faceplates supporting Wireless Access Point (AP) shall:

a. Accept 2 modular jacks or connectors.
b. Be mounted in an enclosure designed for AP.
c. Be high impact, UV resistant plastic white faceplate
d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.

2.6 MODULAR JACK

A. Manufacturers: See "Telecommunications Outlet" above.

B. Modular Jacks shall be: Category 6 jacks

1. 8-position, 8-conductor (8P8C)
2. Non-keyed

C. Jacks shall have an attached color-coded wiring instruction label as an aid to installer.

D. Interface between jack and station cable shall be insulation displacement type contact.

E. Termination components shall maintain cable's pair twists as closely as possible to point of mechanical termination.

F. Jack contacts shall have minimum of 50 micro-inches of gold plating.

G. Jacks shall be supplied with installed dust covers to protect jack opening and internal elements during installation until jack is in use.

1. No damage to Jack pinning shall result from insertion or removal of covers.

H. Data Jack shall:

1. Meet or exceed performance requirements of Category 6 or beyond
2. Shall be yellow in color

I. Voice Jack shall:

1. Meet or exceed performance requirements of Category 6 or beyond
2. Shall be white in color

2.7 FIBER OPTIC CONNECTOR

A. Connectors shall:

1. Be LC duplex type.
2. Accept fibers having clad diameter of 125 microns.
3. Accept fibers having buffered diameter of 900 microns.
4. Sustain minimum of 200 mating cycles.

B. Multimode Connectors shall:

1. Be no-epoxy, no-polish design and include index matching gel in ferrule.

C. Single-mode Connectors shall:

1. Be no-epoxy, no-polish design and include index matching gel in ferrule.

D. Connector ferrule shall be ceramic or glass-in-ceramic.

E. Connectors shall meet the following performance criteria:

	Test Procedure	Max. Attenuation Change
1.	Cable Retention (FOTP-6)	0.2 dB
2.	Durability (FOTP-21)	0.2 dB
3.	Impact (FOTP-2)	0.2 dB
4.	Thermal Shock (FOTP-3)	0.2 dB
5.	Humidity (FOTP-5)	0.2 dB

F. Attenuation per connector shall not exceed 0.5 dB.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to project Drawings for outlet and Consolidation Point locations.

B. Provide Modular Jacks and Fiber Optic couplings (if applicable) in faceplates as shown on Project Documents.

1. Provide 1 faceplate per Telecommunications Outlet symbol shown on Project Documents.
2. Provide 1 modular furniture mounted faceplate per modular furniture symbol shown on Project Documents.

C. Maximum 4-pair Category 6A rated horizontal cable length shall not exceed 90m (295 ft) measured from horizontal cross-connect (typically at TR to Telecommunications Outlet).

1. Includes slack required for installation and termination.
2. Contractor is responsible for installing station cable to avoid unnecessarily long runs.
3. Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.
4. Any cable exceeding the maximum length by more than 3% shall be replaced.
5. 3% excess is equal to less than 304 ft total length.
6. Any cable testing at 304 ft or above shall be replaced.

   a. Cable shall be replaced and retested at no additional cost to owner.
   b. Cable shall also be replaced even in the event that it passes all other design and performance parameters.

7. Excuse that cable twist is responsible for additional length shall be accompanied by letter from manufacturer that their twist is responsible for additional length.

D. Follow manufacturers recommended termination practices.

3.2 CABLE INSTALLATION AND TERMINATION

A. General

1. Refer to Section 270000 - General Communications Requirements and Section 271000 - Structured Cabling for general cable installation requirements.
2. Provide "Service Loop" for every Horizontal Cable in cable tray closest to outlet.
   a. Loop length shall be 3.3 ft (1 meter)
   b. Total length of 4-pair Category-rated horizontal cable including loop shall not exceed 295 ft (90m).
   c. Place loop in ceiling space (cable tray) at last support before cables enter wall, conduit, surface raceway or box.
   d. Coil loop in figure 8 configuration.
   e. Loop radius (minimum) shall be 4X minimum bend radius for cable.
3. During installation, minimum bend radius shall be eight times outside diameter of UTP cables and 20 times outside diameter of fiber cables.

B. Horizontal Copper Twisted-Pair Cabling

1. Provide horizontal copper twisted pair cable between horizontal cross connect (typically at Telecommunications Room) and Telecommunications Outlet.
2. At Telecommunications Outlet, terminate each 4-pair Horizontal Cable on 8P8C Modular Jack.
   a. Terminating one cable on more than one jack is not allowed.
3. At horizontal cross-connect, terminate:
   a. Each 4-pair cable on 8P8C Modular Jack in preferred SCS 110 termination solution.
   b. Each 4-pair cable designated as for "Data" on 8P8C Modular Jack in preferred SCS 110 termination solution.
   c. Each 4-pair cable designated as for "Voice" on 8P8C Modular Jack in preferred SCS 110 termination solution.
4. Terminate station cables on preferred SCS 110 termination solution using T568-B wiring standard.
5. Cable jacket shall be continuous to within 1/2" of termination.
6. Preserve pair twists to point of termination.
7. Refer to Section 271100 - Communications Equipment Room Fittings for termination instructions for Modular Patch Panel and Termination Block.

C. Horizontal Fiber Optic Cable

1. Terminate cables on specified fiber optic connectors at Telecommunications Outlet and at horizontal cross-connect.
   a. Cable termination shall carry fiber buffer into connector strain relief mechanism.
2. Mount connectors in fiber patch panels at horizontal cross-connect as shown on drawings.
3. Refer to Section 271100 - Communications Equipment Room Fittings for termination instructions.

3.3 TELECOMMUNICATIONS OUTLET

A. Faceplates shall be configured to provide connectivity as required by location. Refer to details and drawings.

B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box, raceway or modular furniture.

1. Use faceplate extender if required to provide adequate clearance between jack and furniture or raceway panel to maintain minimum cable bend radius.

3.4 FIELD TESTING

A. Refer to Sections 270000 - General Communications Requirements and 271000 – Structured Cabling for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.

1. In addition, refer to sub-sections below for cable type under test.

B. 4-Pair Horizontal Copper Cable

1. Test from:

a. Horizontal Cross-connect (HC) to Jack at Telecommunications Outlet (TO).
b. Horizontal Cross-connect to Jack at Consolidation Point (CP)
c. HC – CP – TO. Test is in addition to HC-CP test described above.

2. Testing shall be per TIA/EIA-568 (-B1.1 through -B3.1) Permanent Link test configurations.
3. Maximum length of station cable shall not exceed 90 meters.
4. Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).

a. Identify and correct defective, split or mis-positioned pairs.

5. In addition to above, Performance Testing shall be performed on all cables. Testing of Transmission Performance shall include the following:

a. Length
b. Insertion Loss / Attenuation
c. Pair-to-pair NEXT
d. PSNEXT
e. Pair-to-pair ELFEXT (Equal Level Far End Cross-talk)
f. PSEFEXT
g. Return Loss
h. Propagation Delay
i. Delay Skew
j. Alien Cross Talk (ACT)

6. Test cables to maximum frequency defined by standards covering specified performance category.
7. Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.

a. Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.

C. Horizontal Fiber Optic Cable

1. Testing shall include

a. Optical Attenuation

1) Light Source: VCSEL for 850-nm tests; FP LASER for 1300-nm tests
2) Measure Optical Attenuation on terminated fibers.

a) Include optical connectors and couplings installed at fiber endpoints.

3) Test single-mode fibers using EIA/TIA 526-7-1998. Method A.1.

4) Test all fibers in both transmission directions.
5) Test single-mode fibers at 1310 ± 10 nm wavelength.
6) Fiber lengths less than or equal to 300 ft shall test to < 2.0 dB loss.
7) Fiber lengths greater than 300 feet shall test to loss value less than link loss budget for installed connectors and fibers.

2. Perform inspection with OTDR if end-to-end readings are higher than expected to determine source of attenuation. Correct problem(s) and repeat Attenuation measurement until results within specified limits are obtained.

3.5 DOCUMENTATION

A. Refer to Sections 270000 - General Communications Requirements and 271000 – Structured Cabling for documentation guidelines.

B. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations and numbering and other detail necessary to document cable installation.

END OF SECTION 271500

SECTION 275129 - TWO-WAY COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Two-way Communication System.

1.2 DESCRIPTION

A. Refer to Section 270000 - General Communications Requirements.

B. Complete, turnkey Two-way Communication system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

C. Two-way Communication system shall include following major components:

1. Two-way Communication Call Stations
2. Two-way Communication Master Stations
3. Two-way Communication Power Supplies

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0526 - Grounding and Bonding for Communications Systems
3. Section 27 0528.29 - Hangers and Supports for Communications Systems
4. Section 27 0528.33 - Raceway and Boxes for Communications Systems

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Refer to Section 27 0000 - General Communications Requirements.

1.5 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements.

B. Design, cable and component selection, and installation practices shall conform with following:

1. NCBC North Carolina Building Code 2018
2. NFPA 70 - National Electrical Code 2020
3. NFPA 72 - National Fire Alarm and Signaling Code
4. NFPA 101 - Life Safety Code
5. UL 2525 - Standard for Two-Way Emergency Communications Systems for Rescue Assistance

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements.

B. Provide all product data and shop drawings with wiring diagrams.

PART 2 - PRODUCTS

2.1 GENERAL

A. System shall provide full-duplex two-way voice communication between call stations and master station.

B. System shall be listed as compliant with and meeting requirements of UL 2525.

C. If master station is not answered, system shall provide full-duplex two-way voice communication with external constantly attended station and shall automatically communicate location of station initiating call using pre-recorded message unique to each call station.

D. The external station is the public safety office for UNCW.

2.2 TWO-WAY COMMUNICATIONS CALL STATIONS

A. Basis of Design:

1. Rath 2400-808NSP – Owner Preferred Alternate

B. Features:

1. Flush wall-mounted
2. Stainless steel faceplate
3. Red “call received” indicator lamp
4. Microphone
   a. Auto-gain adjustment to account for variable ambient sound level at call station locations
5. Speaker
   a. Auto-level adjustment to account for variable ambient sound level at call station locations

C. Specifications:

1. Operating Environment: 50° - 120° F

2.3 TWO-WAY COMMUNICATIONS MASTER STATIONS

A. Basis of Design:

1. Rath 2500-16RCF

B. Features:

1. Flush wall-mounted
2. Powder-coated steel enclosure with hinged door
3. Visual and audible indication of incoming call
4. Handset
5. Handsfree speakerphone
6. Modem for automatic dial-out

C. Specifications:

1. Operating Environment: 50° - 120° F

2.4 TWO-WAY COMMUNICATIONS POWER SUPPLIES

A. Basis of Design:

1. Rath RP7700104

B. Features:

1. Integral battery backup
2. Secondary power supply (battery backup) shall have sufficient capacity to operate system under quiescent load (system operating in nonalarm condition) for minimum of 24 hours and, at end of that period, shall be capable of operating all alarm notification appliances used for evacuation or to direct aid to location of emergency for 5 minutes.

C. Specifications:

1. Input: 120 VAC
2. Output 24 VDC

2.5 TWO-WAY COMMUNICATIONS CABLE

A. General

1. Refer to manufacturer's published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's published product installation instructions, more stringent requirement shall govern.
2. Cable shall be plenum or riser rated as dictated by environment in which cable is installed.
3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.
4. Two-way Communications system cabling shall be UL 2196 certified and have minimum pathway survivability of Level 2 or 3, provided:

   a. Cable with CIC rating for installation in conduit

2.6 TWO-WAY COMMUNICATION J-TYPE CABLE SUPPORT HOOKS

A. Refer to 27 0528.29 for information and requirements

2.7 TWO-WAY COMMUNICATION RACEWAY AND BOXES

A. Refer to 27 0528.33 for additional information and requirements.

B. Conduit:

1. Minimum 3/4" trade size.
2. No flexible conduit of any type.

C. Boxes:

1. Minimum 4” square 2-1/8” deep.

2.8 SIGNAGE

A. Provide tactile signage for call box instructions. Locate next to each call box.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Wiring color coding for each device type shall be consistent throughout installation.

B. System Supervision

1. System wiring shall be supervised.
2. Two-way telephone communications circuit installation conductors shall be monitored for open circuit and short circuit fault conditions that would cause the telephone communications circuit to become fully or partially inoperative.
   a. Two-way telephone communications circuit fault conditions shall result in trouble signal in accordance with Section 10.14 of NFPA 72.
3. Failure of either primary or secondary power supply shall result in trouble signal in accordance with section 10.14 of NFPA 72.

C. Two-way Communications Call Stations

1. Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.
2. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
3. Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

D. Two-way Communications Master Stations

1. Coordinate rough-in requirements with Division 26 Contractor prior to commencement of work on site.
2. Coordinate exact locations with Owner, Architectural elevations, and work by other trades prior to rough-in.
3. Install in accordance with Americans with Disabilities Act and Americans with Disabilities Act Accessibility Guidelines.

E. Cable

1. Systems Identification:

a. Label system device cabling with unique alphanumeric identifiers that include:

1) Architectural room number
2) Associated system device type
3) Unique alphanumeric identifier

b. Refer to Section 27 0553 for additional information and requirements.

F. Configuration and Programming

1. Coordinate programming with Owner.

3.2 TESTING

A. Schedule and perform system testing with Owner and AHJ present to witness and approve test results.

B. System testing shall include verified acceptable call quality:

1. From each call station to each master station
2. From each call station to external constantly attended station, using voice circuit configured for remote attended station access

C. Each call path shall be tested at:

1. Typical ambient background noise levels at call station and master station
2. Active fire alarm background noise levels at call station and master station

D. Each call station shall be tested to verify proper pre-recorded message unique to each call station is played before initiating two-way voice communication with master station or external constantly attended station.

1. Alternatively, calls to master station can use visual indication of calling station location in lieu of pre-recorded message.

a. Calls to external constantly attended station shall still include pre-recorded message.

3.3 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 1-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

3.4 WARRANTY

A. Contractor shall provide 3-year warranty for the system.

END OF SECTION 275129

SECTION 275319 - EMERGENCY RESPONDER RADIO REINFORCEMENT SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Emergency Responder Radio Reinforcement system.

1.2 DESCRIPTION

A. Design and provision of a complete, turnkey Emergency Responder Radio Reinforcement system compliant with all applicable codes and standards referenced herein and as indicated on drawings.

B. The Emergency Responder Radio Reinforcement system shall include the following major components:

1. Donor Antenna(s)
2. Surge Protection
3. Bi-Directional Amplifier / Repeater
4. Splitters
5. Directional Couplers/Taps
6. Coverage Antennas
7. Uninterruptible Power Supplies

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 270000 - General Communications Requirements
2. Section 270526 - Grounding and Bonding for Communications Systems
3. Section 270528.29 - Hangers and Supports for Communications Systems
4. Section 270528.33 - Raceway and Boxes for Communications Systems
5. Section 271000 – Structured Cabling

B. Related sections in other Divisions of Work:

1. Section 260527 - Lightning Protection System

1.4 REFERENCES AND STANDARDS

A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:

1. United States Table of Frequency Allocations, current version
2. Federal Communications Commission Table of Frequency Allocations, current version
3. FCC 47 CFR Part 90.219
4. FCC OET Bulletin 65
5. IFC International Fire Code
6. UL 2524 Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems
7. NFPA 1: Fire Code
8. NFPA 72: National Fire Alarm and Signaling Code

9. NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
10. NCFC North Carolina Fire Code 2018

1.5 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, following abbreviations and acronyms shall apply to this document:

1. ACG: Automatic Gain Control
2. AHJ: Authority Having Jurisdiction
3. ATP: Acceptance Test Plan
4. AWS: Advanced Wireless Service
5. BDA: Bi-Directional Amplifier
6. BOM: Bill-of-Material
7. BRS: Broadband Radio Service
8. BTS: Base Transceiver Station
9. CDMA: Code Division Multiple Access
10. C/N: Carrier-to-Noise Ratio
11. CWDM: Coarse Wave Division Multiplexing
12. DAS: Two-way Radio Communications Enhancement System
13. DAQ: Delivered Audio Quality
14. DWDM: Dense Wave Division Multiplexing
15. EBS: Educational Broadband Service
16. ESMR: Enhanced Specialized Mobile Radio
17. ERRC: Emergency Responder Radio Coverage
18. FCC: Federal Communications Commission
19. GUI: Graphical User Interface
20. iDEN: Integrated Enhanced Digital Network
21. LMR: Land Mobile Radio
22. LTE: Long Term Evolution
23. MIMO: Multiple-Input and Multiple-Output
24. MTBF: Mean Time Between Failure
25. NFPA: National Fire Protection Association
26. NMS: Network Management System
27. NTIA: National Telecommunications and Information Administration
28. PCS: Personal Communications System
29. PSE: Public Safety Entity
30. PSN: Public Safety Network
31. RF: Radio Frequency
32. RoF: Radio-over-Fiber
33. RoHS: Restriction of Hazardous Substances
34. RSL: Received Signal Level
35. RX: Receive
36. SISO: Single-Input, Single-Output
37. SMR: Specialized Mobile Radio
38. SMS: Short Message Service
39. SNMP: Simple Network Management Protocol
40. SOW: Statement of Work
41. TSL: Transmit Signal Level
42. TX: Transmit
43. VSWR: Voltage Standing Wave Ratio

1.6 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements for general terminology used in Division 27 sections.

B. In addition, the following definitions are applicable to this document:

1. Active: DAS components that require AC/DC power for operation
2. Channel: A path for an RF transmission between two points
3. Component: A main system element of the DAS
4. Contractor: The prime contractor bidding the project
5. Passive: DAS components that do not require AC/DC power for operation

1.7 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. In addition, Submit:

1. Initial RF site survey and analysis report, to include:

   a. Data collection point locations
   b. RF spectrum shots
   c. RF data plot maps

2. Floor plans documenting proposed coverage antenna locations
3. Floor plans documenting proposed donor antenna location
4. RF propagation modeling maps
5. Documentation that each PSN has reviewed and approved proposed equipment and Contractor's design
6. Follow-up RF site survey and analysis report, to include:

   a. Data collection point locations
   b. RF spectrum shots
   c. RF data plot maps
   d. Documentation of changes to initial system design required due to results of follow-up RF site survey, where required, to include as applicable:

      1) Floor plans documenting proposed coverage antenna locations
      2) RF propagation modeling maps
      3) Documentation that each PSN has reviewed and approved proposed equipment and Contractor's design

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment required to provide emergency responder radio coverage shall be listed in accordance with UL 2524.

B. System shall be a BDA style turnkey system capable of integral support of RF signals for PSNs managed by FCC.

C. System shall support each PSN on each frequency currently being used by PSEs serving project area.

1. Coordinate directly with each PSE prior to the commencement of design work to confirm frequencies active on the project's scheduled date of substantial completion.

D. System shall be expandable to support each frequency band allocated by FCC for PSN use without replacement of or addition to the system's passive infrastructure.

E. System shall be capable of receiving PSN AHJ approval.

F. System shall include filtering of all frequencies unused by PSN signals in area in which project is located.

G. System shall be capable of upgrade, without need for additional hardware or software, to support changes to other frequencies within deployed frequency bands to maintain PSN coverage as originally designed.

H. System shall be expandable to extend coverage for all Public Safety frequencies supported to future new additions without need for additional head end equipment.

I. Passive system components shall be:

1. Broadband
2. PIM (passive intermodulation) compliant

J. Active RF emitting devices used in emergency responder radio coverage systems shall have built-in oscillation detection and control circuitry.

2.2 ANTENNAS

A. General

1. Antennas shall feature multi-band design accommodating multiple frequency bands in a single wall-mounted antenna

B. Broadband Donor Antenna

1. Antennas shall feature multi-band design accommodating applicable Public Safety frequencies in a single pole-mounted antenna.
2. Temperature range: -40°C(-40°F) to 60°C(140°F).
3. Rated for outdoor use.

C. Coverage Antennas – Omnidirectional

1. Antenna beam width:

a. Horizontal: 360° omnidirectional
b. Vertical: 65-80° nominal

2. Temperature range: -40°C(-40°F) to 60°C(140°F).
3. Rated for indoor use.

D. Coverage Antennas - Directional

1. Antenna beam width:

a. Horizontal: 110° directional
b. Vertical: 90° nominal

2. Temperature range: -40°C(-40°F) to 60°C(140°F).
3. Rated for indoor use.

2.3 BI-DIRECTIONAL AMPLIFIERS

A. Where BDA is used to drive DAS, BDA shall be modular design and use digital filtering to mitigate interference.

B. BDA shall be standard 19" rack or wall mountable.

C. BDA shall be able to individually control power level of each frequency band amplified.

2.4 CABLING

A. Backbone, antenna distribution, radiating, and fiber optic cables shall be plenum rated in conduit.

B. All conduit shall be in a two-hour rated enclosure or shaft.

PART 3 - EXECUTION

3.1 PSN SUPPORT COORDINATION MEETING

A. Prior to Contractor's design work commencement, Contractor shall arrange and conduct coordination meeting to review and coordinate Emergency Responder Radio Reinforcement system support of PSN frequencies.

1. At minimum, attendees shall include:

   a. AHJ and representatives of public safety entities utilizing supported PSN frequencies
   b. Owner's project manager, facilities/buildings and grounds/maintenance representative, security representative, and information technology/information systems representative
   c. Construction Manager project manager and site superintendent/field foreman
   d. Division 26 site superintendent/field foreman
   e. Division 27 project manager and site superintendent/field foreman
   f. Emergency Responder Radio Reinforcement subcontractor/supplier project manager

2. At minimum, meeting agenda topics shall include:

   a. Confirmation of PSN frequencies and channel loading currently being used by PSEs serving project area
   b. Identification of planned or potential changes in active frequencies and/or channel loading that may be implemented prior to scheduled date of substantial project completion
   c. Identification and discussion of proposed system's functional capabilities and limitations
   d. Step-by-step review of system design and deployment execution plan
   e. Review of survey, design, installation, configuration, programming, and testing schedule and of how those relate to overall construction schedule, including identification of interdependencies, project milestones, and critical dates.

3. Meeting shall be scheduled with minimum of two weeks' notice.

   a. Contractor shall publish meeting agenda and distribute agenda and configuration and programming guide to invited attendees minimum of one week prior to meeting.

4. Contractor shall take detailed notes during meeting and publish meeting minutes within one week after meeting. Minutes shall be distributed to attendees, Architect, and Engineer, and be included in Operation and Maintenance Manual.

3.2 PRE-DESIGN SITE SURVEY

A. After specified coordination meetings and before completion of design, Contractor shall conduct pre-design site survey.

B. Data collection points shall:

1. Include potential donor antenna locations and elevations

   a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.

2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
3. Be sufficient in quantity and location to properly inform Contractor's design

C. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

3.3 DESIGN

A. Where DAS is used in lieu of a two-way in-building wired emergency communications system, DAS design shall be approved by AHJ.

B. Contractor is solely responsible for design of Emergency Responder Radio Reinforcement System.

C. Contractor shall design Emergency Responder Radio Reinforcement System in accordance with manufacturer's instructions and recommendations, industry standard best practices, and requirements of supported PSNs. Where discrepancies arise, more stringent requirement will govern.

D. Contractor shall design Emergency Responder Radio Reinforcement System to provide performance specified herein throughout the coverage areas and to meet approval of all supported PSNs.

E. Refer to Architectural drawings for building occupant information.

3.4 PRE-INSTALLATION SITE SURVEY

A. Contractor shall conduct pre-installation site survey no more than thirty (30) days prior to commencement of installation work on site to acquire updated measurement data.

1. Pre-installation site survey shall be conducted after walls are built and after glazing is installed.
2. Where pre-design site survey is conducted within thirty days of commencement of installation work and fulfills all requirements for both pre-design site survey and pre-installation site survey, separate pre-installation site survey is not required.

B. Data collection points shall:

1. Include potential donor antenna locations and elevations

   a. Every effort shall be made to be accurate in locating potential donor antenna locations and elevations on site during survey, to ensure survey measurements are conducted within 10 feet of actual locations, including elevation.

2. Be sufficient in quantity and location to provide accurate and sufficiently granular data throughout coverage areas
3. Be sufficient in quantity and location to properly verify Contractor's design

C. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies
3. Continuous wave (CW) testing to validate propagation modeling

D. Survey data shall be submitted to Architect and Engineer and be included in Operation and Maintenance Manual.

E. Contractor shall update their design as required by updated survey data.

3.5 WORK SEQUENCE

A. Coordinate schedule of Emergency Responder Radio Reinforcement system work to ensure Certificate of Occupancy is obtained in accordance with project schedule.

3.6 EQUIPMENT SUPPORTS

A. Donor Antenna Mounts

1. Donor antenna assemblies including antenna(s), antenna cable, antenna mount/mast, and associated accessories and hardware shall be designed and installed to withstand sustained winds of ≥ 100 miles per hour from any direction with all devices, equipment, and material installed and with up to 6 inches of radial ice accumulated.
2. Make donor antenna mounts/masts and associated components, accessories, and hardware electrically continuous and properly ground to lightning protection system. Refer to Section 26 0527 for conductor sizing and termination requirements, and for additional information and requirements.

3.7 INSTALLATION

A. Design and installation shall be performed and overseen by FCC GROL licensed technician employed by installing contractor.

B. Equipment Locations

1. Install antenna(s) in coverage areas.
2. Install donor antenna and main system head end equipment where indicated on drawings.
3. Install system floor-level equipment (splitters, directional couplers / taps, etc.) where indicated on drawings in telecommunications rooms. Refer to drawings for additional information.
4. Active system components, including transmitter, receiver, signal booster components, external filters and battery system components, shall be contained in NEMA 4 or 4X enclosures.

C. Power Supplies

1. Primary power source

a. Emergency Responder Radio Reinforcement system active electronics shall be fed via minimum 20-amp emergency power electrical circuit(s), dedicated to Emergency Responder Radio Reinforcement system head end equipment.

2. Secondary power source

a. System shall include battery back-up sufficient to power system at 100 percent system operation for minimum of twenty-four (24) hours.

3. Coordinate power requirements, quantities, connection locations, and schedule for activating power with on-site Division 26 Contractor prior to commencement of work on site.

D. Cabling

1. Riser cables shall be routed through 2-hour rated enclosure in conduit.
2. Connection between riser and feeder cables shall be made within 2-hour rated enclosure.

a. Passage of feeder cable in and out of 2-hour rated enclosure shall be fire-stopped to 2-hour ratings.

E. Properly ground system components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.

1. Refer to Section 27 0526 for additional information and requirements.

F. Provide and configure filtering to maximize composite power for PSN frequencies being supported.

G. Properly terminate unused RF ports on system devices, including amplifiers, splitters, directional coupler / taps, etc.

H. Donor Antennas

1. Coordinate donor antenna locations and mounting method with Architect and GC prior to rough-in.
2. Fasten donor antennas and associated mounting components. with stainless steel fasteners.
3. Bond donor antenna cables to ground at point where cable connects to antenna and at point where cable transfers off antenna mounting structure.
4. Provide in-line surge protection on antenna cables, at point where cable enters building.

a. Properly ground surge protection components with minimum 6 AWG bonding conductor terminated with two-hole compression lugs.
b. Refer to Section 27 0526 for additional information and requirements.

5. Weatherproof exterior antenna cable connections with manufacturer-approved assembly.

I. Coverage Antennas shall be installed in accessible ceilings. Coordinate antenna locations with work by other trades to ensure that direct access to antenna is maintained after project completion.

J. System shall provide uniform coverage. Radio coverage shall be provided throughout building as percentage of floor area.

1. Building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95 percent of all areas on each floor of building meet signal strength requirements.
2. Minimum signal strength of -95 dBm shall be receivable within the building.

3. Critical areas, including fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by AHJ, shall be provided with 99 percent floor area radio coverage.
    a. General building areas shall be provided with 90 percent floor area radio coverage.
4. Minimum inbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Inbound signal level shall be sufficient to provide minimum of DAQ 3.0 for either analog or digital signals.
5. Minimum outbound signal strength sufficient to provide usable voice communications, as specified by AHJ, shall be provided throughout coverage area. Outbound signal level shall be sufficient to provide minimum DAQ 3.0 for either analog or digital signals.
6. Isolation shall be maintained between donor antenna and inside antennas to minimum of 20 dB under operating conditions.

K. System shall not interfere with operation of other electronic systems.

3.8 SYSTEM MONITORING

A. Fire Alarm System

1. System shall include automatic supervisory signals for malfunctions of emergency responder radio reinforcement system annunciated by fire alarm system in accordance with NFPA 72.
    a. Monitoring for system integrity shall comply with NFPA 72, Chapter 10.
    b. Provide visual and labeled indications for each supervised system component.
    c. System supervisory signals shall include:
        1) Donor antenna malfunction
        2) Active RF emitting device failure
        3) Low-battery capacity indication when 70 percent of the 24-hour operating capacity has been depleted
        4) System component failure
    d. Power supply supervisory signals shall include the following for each RF emitting device and system component:
        1) Loss of normal AC power
        2) Failure of battery charger
    e. Communications link between fire alarm system and emergency responder radio reinforcement system shall be monitored for integrity.

B. Dedicated Panel

1. Dedicated monitoring panel shall be provided to annunciate status of RF emitting devices and system component locations. Monitoring panel shall provide visual and labeled indications of following for each system component and RF emitting device:
    a. Normal AC power
    b. Loss of normal AC power
    c. Battery charger failure
    d. Low battery capacity (to 70 percent depletion)
    e. Donor antenna malfunction
    f. Active RF emitting device malfunction
    g. System component malfunction
2. Communications link between dedicated monitoring panel and emergency responder radio reinforcement system must be monitored for integrity.

3.9 INSPECTION AND TESTING

A. Test plan shall include tests necessary to verify that installed system meets specified requirements and requirements of each PSE.

B. Scheduling

1. Testing shall be scheduled minimum of two weeks prior to scheduled date of final completion.

a. Contractor shall coordinate with each PSE to arrange for them to observe system testing.

C. Data collection points

1. Data collection points shall include:

a. All donor antenna locations
b. Signal level at each stair landing and elevator lobby
c. Signal level at locations as required by AHJ

2. Be sufficient in quantity and location to properly verify that system's performance meets specified requirements and requirements of each PSE.

a. At a minimum, each floor shall be divided into twenty equal areas and data shall be collected at or as near as is practical to the center of each area.

D. Survey measurements shall include:

1. Baseline RF noise at and adjacent to supported frequencies
2. Signal strength of each supported PSN's macro signals, at supported frequencies
3. Signal strength of each supported PSN's system coverage signals, at all supported frequencies

E. At no additional cost to Owner, Contractor shall adjust, modify, and/or add to system as necessary to achieve performance required by AHJ.

3.10 ATTIC STOCK

A. Contractor shall provide following spare devices and equipment as Owner's attic stock:

1. Donor Antennas: One (1) of each type provided
2. Coverage Antennas: Five (5) of each type provided
3. Surge Suppressors: 100% of the quantity installed of each type provided.
4. Fuses: 20% of each type provided as part of system devices and equipment, minimum ten (10) of each type provided.

3.11 TRAINING

A. Contractor shall provide to Owner's designated representative(s) a minimum of one (1) 4-hour on-site training session related to work under this section within thirty (30) days of substantial completion.

END OF SECTION 275319

SECTION 280000 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This Section details references, standards, guidelines, requirements, conditions, etc. common to Division 28 work. Unless noted otherwise, work under related Division 28 Sections is subject to requirements of this Section.

B. Work under this Section and related Sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under General Requirements.

C. Systems constituting the Division 28 scope of work include, but are not limited to:

1. Electronic Access Control
2. Video Management System

1.2 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete, turnkey systems which are furnished, installed, configured, tested, adjusted, and made completely ready for operation.

B. Contract documents are performance-based and diagrammatic, intended to convey the scope of work, design intent, and general arrangement of devices, equipment, etc. and define the minimum material quality, required features, operational requirements, and performance of the systems. Contract documents do not convey every required conductor, every required connection, or every required configuration or programming detail. Information provided in contract documents is as exact as could be secured but is not guaranteed. Contractor is solely responsible for determining devices, components, equipment, accessories, wiring, connections, terminations, configuration, programming, etc. to provide a complete and operational turnkey system that satisfies the scope of work and design intent conveyed.

C. Contractor is solely responsible for determination of quantities of equipment, devices, material etc. based on the information provided in the contract documents. Where discrepancies arise, the greater number shall govern.

D. Work related to Electronic Safety and Security in contract documents of other Divisions of Work shall be included as part of work under this Division.

E. If work and/or material, devices, equipment, etc. is depicted on the drawings, required in the specifications, specified in other contract documents, or necessary for proper operation and satisfying the scope of work and design intent conveyed, it shall be considered part of this contract. Contractor shall include in their bid costs associated with the work and material, devices, equipment, etc. depicted on the drawings, required in the specifications, specified in other contract documents, and necessary for proper operation and satisfying the scope of work and design intent conveyed.

F. Prior to submitting a bid, Contractor shall notify the Owner of necessary work the Contractor believes to be omitted from the Contract Documents, and of products specified the Contractor believes to be improper or inadequate.

G. Coordinate all work with UNCW Security.

H. Programming and licensing of all security systems to be executed by UNCW preferred contractors in order to support integration with existing UNCW regional Security Operation Centers (SOC).

1.3 RELATED WORK

A. Coordination for integrating electronic and electrical systems and equipment with Door Hardware (Architect and General Contractor)

B. Related Division 28 Sections include:

1. Section 28 0513 - Conductors and Cables for Electronic Security
2. Section 28 1300 - Access Control
3. Section 28 2300 - Video Surveillance System
4. Section 28 3116 - Fire Detection and Alarm Systems

C. Related Divisions of Work and related sections in other Divisions of Work:

1. Division 26 - Electrical

a. Section 26 0529 - Hangers and Supports for Electrical Systems
b. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems
c. Section 26 0533 - Raceway and Boxes for Electrical Systems
d. Section 26 0593 - Electrical Systems Firestopping

2. Division 27 - Communications

a. Section 27 0526 – Grounding and Bonding for Communications Systems
b. Section 27 0553 - Communications Systems Identification
c. Section 27 1000 - Structured Cabling
d. Section 27 1100 - Communications Equipment Room Fittings
e. Section 27 1500 - Communications Horizontal Cabling
f. Section 27 1600 - Communication Connecting Cords, Devices and Adapters

D. Refer to individual technical sections identified above for additional related sections.

E. Refer to UNCW Security Standards for further information.

F. Rules and regulations of Federal, State, and local authorities and of utility companies serving the project site in force at time of execution of contract shall become part of this specification.

G. Perform work in accordance with laws, codes, regulations, ordinances, etc. of the jurisdiction in which the project site is located and in accordance with Owner's published standards.

H. Perform work in accordance with referenced standards, guidelines, and industry best practices.

I. Perform work in accordance with manufacturer's instructions, guidelines, recommendations, etc.

J. Where a discrepancy exists between laws, codes, regulations, ordinances, guidelines, industry best practices, Owner's published standards, manufacturer's instructions, manufacturer's guidelines, manufacturer's recommendations, etc. and contract documents, the most stringent requirement or direction that complies with laws, codes, regulations, and ordinances shall govern.

K. Changes to work conveyed by the contract documents made after the letting of the contract to comply with applicable laws, codes, regulations, ordinances, Owner's published standards, or contract documents or to comply with the requirements of the Authority Having Jurisdiction shall be made by the Contractor without any cost to the Owner.

L. Contractor shall include in their bid costs to procure permits, licenses, approvals, etc. applicable to work performed, including:

1. Costs to prepare documents for applications, submittals, etc. for review by Authority Having Jurisdiction
2. Application, submittal, etc. charges, fees, taxes, etc.

M. Contractor shall include in their bid costs for inspections of work performed related to permits, licenses, approvals, etc. or laws, codes, regulations, ordinances, or Owner's published standards.

1.4 REFERENCES AND STANDARDS

A. Unless otherwise noted, design, products, installation, and completed work shall conform with the current version of the following, including applicable addenda and errata:

1. Country, State, and local safety and building codes
2. Americans with Disabilities Act
3. ADA Standards for Accessible Design
4. ANSI/ASIS PAP.1-2012 - Security Management Standard: Physical Asset Protection
5. ANSI/ASIS SPC.1-2009 - Organizational Resilience: Security, Preparedness, and Continuity Management Systems - Requirements with Guidance for Use
6. ANSI/IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
7. ANSI/IEEE 1100: Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
8. ANSI/IEEE C2: National Electrical Safety Code
9. ANSI/TIA-606-C: Administration Standard for Telecommunications Infrastructure
10. ANSI/TIA-607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises Standard
11. ANSI/TIA-5017: Telecommunications Physical Network Security Standard
12. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
13. ASTM E-814: Standard Test Method for Fire Tests of Through-Penetration Firestops
14. IEEE 802.3af and 802.3at: Power-over-Ethernet Standards.
15. IEEE 802.3an: 10 Gigabit Standard
16. IEEE 837: Standard for Qualifying Permanent Connections Used in Substation Grounding.
17. NFPA 70: National Electrical Code
18. NFPA 101: Life Safety Code
19. NFPA 780: Standard for the Installation of Lightning Protection Systems
20. NECA/BICSI 607: Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
21. TIA TSB-184: Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
22. TIA TSB-185: Environmental Classification (MICE) Tutorial
23. TIA TSB-190: Guidelines on Shared Pathways and Shared Sheaths
24. UL 94: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
25. UL 96 - Lightning Protection Components
26. UL 96A - Installation Requirements for Lightning Protection Systems
27. UL 294 - Standard for Access Control System Units
28. UL 294B - Standard for Power Over Ethernet (PoE) Power Sources for Access Control Systems and Equipment

29. UL 365 - Standard for Police Station Connected Burglar Alarm Units and Systems
30. UL 444: Communications Cables
31. UL 467: Electrical Grounding and Bonding Equipment
32. UL 603 - Standard for Power Supplies for Use with Burglar-Alarm Systems
33. UL 609 - Standard for Local Burglar Alarm Units and Systems
34. UL 634 - Standard for Connectors and Switches for Use with Burglar-Alarm Systems
35. UL 723 - Surface Burning Characteristics of Building Materials
36. UL 827 - Standard for Central-Station Alarm Services
37. UL 1034 - Standard for Burglary-Resistant Electric Locking Mechanisms
38. UL 1037 - Standard for Antitheft Alarms and Devices
39. UL 1076 - Standard for Proprietary Burglar Alarm Units and Systems
40. UL 1479 - Fire Tests of Through-Penetration Firestops
41. UL 1610 - Standard for Central-Station Burglar-Alarm Units
42. UL 1635 - Standard for Digital Alarm Communicator System Units
43. UL 1666 - Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
44. UL 2044 - Standard for Commercial Closed-Circuit Television Equipment
45. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)

B. Design, cable and component selection, and installation practices shall also conform with additional standards identified in individual Technical Sections.

1.5 ABBREVIATIONS AND ACRONYMS

A. Agencies or publications referenced herein refer to the following:

1. ANSI American National Standards Institute
2. ASIS American Society of Industrial Security
3. ASME American Society of Mechanical Engineers
4. ASTM American Society for Testing and Materials
5. BICSI Building Industry Consulting Services International
6. EIA Electronic Industries Alliance
7. FIPS Federal Information Processing Standards
8. FCC Federal Communications Commission
9. ICEA Insulated Cable Engineers Association
10. IEEE Institute of Electrical and Electronics Engineers
11. NEC National Electrical Code
12. NECA National Electrical Contractors Association
13. NEMA National Electrical Manufacturers Association
14. NESC National Electrical Safety Code
15. NETA National Electrical Testing Association
16. NFPA National Fire Protection Association
17. NIST National Institute of Standards and Technology
18. OSHA Occupational Safety and Health Administration
19. TIA Telecommunications Industry Association
20. UL Underwriters Laboratories, Inc.

B. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. AFF Above Finished Floor
2. AWG American Wire Gauge
3. CCTV Closed-Circuit Television
4. CM Communications cable rated for General Purpose use

5. CMP Communications cable rated for use in Plenum areas
6. CMR Communications cable rated for use in Risers and vertical runs
7. EIA Electronic Industries Alliance
8. ft. feet
9. GbE Gigabit Ethernet
10. ID Inside Diameter
11. IDF Intermediate Distribution Frame
12. in inch
13. lbs. pounds
14. LAN Local Area Network
15. Mbps Megabits per second
16. OD Outside Diameter
17. PoE Power-over-Ethernet
18. PVC Polyvinyl Chloride
19. RU Rack Unit
20. sq. ft. square feet (area)
21. UTP Unshielded Twisted Pair
22. VoIP Voice over Internet Protocol
23. WAN Wide Area Network
24. WLAN Wireless Local Area Network

C. Refer to technical sections for additional terminology.

1.6 DEFINITIONS

A. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 28 contract documents shall have the following meanings:

1. "Provide" shall mean "furnish, install, configure, test, adjust, etc. and make completely ready for operation".
2. "Furnish" does not include installation, configuration, testing, adjusting, etc.
3. "Install" shall mean “install, configure, test, adjust, etc. and make completely ready for operation” but does not include furnishing.

B. Acceptance: Expressed approval

C. The following definitions are applicable to Electronic Safety and Security environments and shall apply to this document and its companion sections for clarification and direction.

1. Auxiliary Intelligent Controllers (AIX) or Auxiliary I/O Controllers (AIO). Controllers that are located near a served access control door and not in the Master Intelligent Controller Location.
2. CCTV: Closed-circuit television/Video Surveillance
3. CPU: Central processing unit.
4. Cable - assembly of 1 or more conductors or optical fibers within enveloping sheath, constructed so as to permit use of conductors singly or in groups.
5. Cable ID - unique alpha-numeric identification used for tagging of backbone or horizontal cabling.
6. Contractor: Electronic Safety and Security Contractor or sub-contractor(s) responsible for installation, termination, test and documentation of Electronic Safety and Security equipment, devices, cabling, pathway hardware, equipment room hardware, and related components detailed in technical sections of this Division of work.
7. Credential: Data assigned to an entity and used to identify that entity.
8. Equipment Room (Security): an environmentally controlled centralized space for Electronic Safety and Security equipment that usually houses head end equipment, servers, control panels, power supplies, and system cabling terminations.

9. GFI: Ground fault interrupter.
10. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
11. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
12. Intra-building - within single building.
13. Intelligent Controller: An access control controller containing a database of cardholders and system operation parameters that allow it to operate independently from the system Server when the communications between the Server and the Intelligent Controller is not available.
14. Inter-building - between 2 or more buildings.
15. Intra-building - within single building.
16. I/O controllers: Input/Output controllers that provide a wiring interface to field devices,
17. LAN: Local area network.
18. Master Intelligent Controller (MIC). An intelligent controller that connects to Auxiliary Intelligent Controllers or Auxiliary I/O controllers I/O controllers over TCP/IP or EIA-485 communications networks.
19. Location: A Location in the building having a Master or Auxiliary Intelligent Controller. Where this term is presented with an initial capital letter, this definition applies.
20. PC: Personal computer. Applies to the, main and auxiliary workstations.
21. Proximity Card: Magnetic principle that uses specially treated wires embedded in the credential card.
22. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 44.5 mm(1-3/4”) high.
23. RF: Radio frequency.
24. ROM: Read-only memory. ROM data are maintained through losses of power.
25. Server: Computer configured as an access control system application and file server.
26. Service Loop - Surplus cable, typically located at or near point of termination to enable future changes.
27. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
28. UPS: Uninterruptible power supply.
29. USB: Universal serial bus.
30. WAN: Wide area network.
31. WAV: The digital audio format used in Microsoft Windows.
32. WMP: Windows media player.
33. Wiegand: Cable and signal protocol
34. Windows: Operating system by Microsoft Corporation.
35. Workstation: A PC with software that is configured for specific, limited security-system functions.

1.7 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

B. Products

1. Only products of reputable manufacturers, as determined by the Owner/Engineer, will be acceptable. Manufacturers shall have a minimum of five (5) years of documented experience in designing, manufacturing, delivering, and supporting the specified material.

2. Where contract documents require a product, material, or assembly that hasn't been specified by brand or trade name, provide product, material, or assembly that meets the specified requirements, as supplied and warranted by the system vendor. If system vendor does not offer product, material, or assembly, provide product, material, or assembly per system vendor's recommendation.

C. Contractor

1. Contractors shall have a minimum of five (5) years' documented experience providing and servicing the specified equipment, devices, components, materials, and systems.
2. Contractor shall have documented history of successfully completing a minimum of three (3) projects of a scope and magnitude equal to or greater than that specified in the Contract Documents.
3. Contractor shall have a minimum of five (5) years' documented history of being continuously current on manufacturer's training and certifications applicable to the specified equipment, devices, components, materials, and systems they propose for use on the project.
4. Contractor shall have a minimum of five (5) years' documented history of being certified by the manufacturer to offer and support manufacturer warranties applicable to the specified equipment, devices, components, materials, and systems they propose for use on the project.
5. Contractor's staff assigned as project manager, site superintendent, and foreman shall each have documented history of successfully completing a minimum of three (3) projects of a scope and magnitude equal to or greater than that specified in the Contract Documents.
6. Contractor's staff assigned as site superintendent and foreman and Contractor's staff assigned to perform installation, termination, configuration, programming, and testing shall have a minimum of five (5) years' documented experience of being continuously, individually certified by the manufacturer on the specified equipment, devices, components, materials, and systems proposed and approved for use on the project.
7. Contractor shall have an in-house service department staffed with technicians who are individually manufacturer-certified to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on the project, and who are equipped with tools, equipment, materials, etc. necessary to install and service specified equipment, devices, components, materials, and systems proposed and approved for use on the project.

    a. Contractor's in-house service division/department/staff shall offer maximum 8-hour on-site service call response time 24 hours a day, 7 days a week, 365(6) days a year.

8. Contractors and subcontractors shall only employ workers who are properly trained to execute the work being performed and are skilled in their trade.
9. Contractors and subcontractors shall own and maintain equipment, tools, etc. to execute the work performed in a manner consistent with laws, codes, regulations, ordinances, standards, guidelines, industry best practices, manufacturer's instructions, etc.. Workers shall be properly trained in the use of equipment, tools, etc. necessary for them to complete the work performed.
10. Contractor shall submit with shop drawings documentation of compliance with requirements listed above. Inability to demonstrate compliance with requirements listed above shall disqualify Contractor from self-performing the work conveyed by the contract documents, and Contractor shall then, at no additional cost to Owner, subcontract with another firm qualified to perform the work.

1.8 SUBMITTALS

A. General:

1. Refer to individual technical sections for additional information and requirements.
2. Submittals shall be prepared and submitted in electronic form.

    a. Unless noted otherwise, documents submitted in electronic form shall be in .pdf format.

B. Shop Drawings:

1. The Owner reserves the right to make changes to descriptive information, component selection and nomenclature during shop drawing review without incurring and additional cost.
2. Submit shop drawings or product data as soon as practicable after execution of contracts. Submittals must be approved before materials are ordered, delivered to site, or installed.
3. Group submittals by Specification Section to include complete documentation of related systems, products and accessories. Submittals for systems, assemblies, etc. consisting of more than one item, component, etc. shall be made for the system or assembly as a whole. Partial submittals for such systems, assemblies, etc. will be rejected in their entirety and returned for resubmittal without review.
4. Provide a table of contents for each Specification Section, to include each item being submitted. Each table of contents entry shall include:
   a. Nomenclature applied in the specifications and/or on the drawings to describe the item (e.g., “18/2 Unshielded Cable”)
   b. Manufacturer and part number, where applicable
   c. Reference to Specification Section or drawing where item is specified (e.g., “280000 - 1.10 - B - 6 - c” or “Drawing T000”)
5. Prepare submittals to include information required to demonstrate understanding of and compliance with requirements of the contract documents.
   a. Where submitted information does not demonstrate compliance with requirements of the contract documents, discrepancies shall be so noted and an explanation for the discrepancy shall be provided.
6. Provide documentation demonstrating compliance with requirements specified in 280000 - 1.9 - Quality Assurance above.
7. Provide manufacturer’s product data for each item, component, device, and material proposed for the system. At a minimum, the data submitted shall clearly demonstrate compliance with each requirement specified in the contract documents.
   a. Submitted product data shall include electrical power consumption, BTU output, contact ratings, and wiring diagrams for electrically powered or controlled equipment.
   b. Where equipment and items specified include components, parts, sub-assemblies, accessories, additional items, etc. under one designation, submittals shall be complete and include required components.
   c. Where accessories, peripheral materials, consumables, additional items, etc. are required to provide the specified performance and functionality or to facilitate installation, submittals shall be complete and include such items.
   d. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
   e. Where obtaining a proposed item, component, device, or material involves a lead time of more than ten (10) working days, Contractor shall note the lead time quoted by the distributor, supplier, or vendor and provide an explanation of factors contributing to the lead time.
   f. Manufacturer’s product data sheets submitted shall be original full color versions of those documents. Black and white or greyscale versions of documents originally issued by the manufacturer in full color will be rejected in their entirety and returned for resubmittal without review.
   g. Where manufacturer’s product data sheets include multiple part numbers, mark the sheets to indicate specific items being submitted.
      1) Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
      2) Where product data includes multiple product options, mark proposed option(s).

h. Mark manufacturer's product data sheets with nomenclature applied in the specifications and/or on the drawings to describe the item (e.g., "18/2 Unshielded Cable")
i. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item and explanation for the discrepancy.
j. Where applicable, dimensions shall be marked in units to match those specified.

8. Provide CAD-generated, scaled, project-specific floor plan drawings for each discrete system, depicting equipment, device, component, etc. locations and main system cabling pathway routes.

   a. Drawings shall be Contractor-generated. Submitting copies of bid or construction documents is not an acceptable means of fulfilling this requirement.
   b. Drawings shall include legends defining symbols, abbreviations, etc. used in the diagrams.

9. Provide CAD-generated, scaled, project-specific equipment room layout drawings for each equipment room, depicting size and layout of equipment, raceways, accessories, working clearances, etc.

   a. Drawings shall be Contractor-generated. Submitting copies of bid or construction documents is not an acceptable means of fulfilling this requirement.
   b. Drawings shall include legends defining symbols, abbreviations, etc. used in the diagrams.

10. Provide for each system a CAD-generated project-specific system block diagram that clearly depicts system components and wiring, including proposed type and size of each conductor, and clearly illustrates system topology, interconnections between system components, location of major system equipment, and integration interconnections between otherwise discrete systems.

    a. Where system includes multiple instances of an identical component or device in an identical configuration, diagram may depict a single, typical instance of that component or device labeled as typical, so long as doing so does not negatively impact the diagram's ability to effectively convey pertinent system information in a complete manner. Owner/Engineer will make final determination on whether a "typical" depiction is acceptable.
    b. Diagrams shall depict used and unused/spare input and output connection points on equipment, devices, components, etc.
    c. Diagrams shall depict equipment, device, component, etc. connections to electrical power sources.
    d. Diagrams shall include legends defining symbols, abbreviations, etc. used in the diagrams.
    e. Diagrams shall be Contractor-generated. Copies of Contract Documents shall not fulfill this requirement and will be rejected in their entirety and returned for resubmittal without review.
    f. Diagrams shall be project-specific. Generic diagrams shall not fulfill this requirement and will be rejected in their entirety and returned for resubmittal without review.

11. Provide for each piece of equipment, device, component, etc. CAD-generated installation details, to include mounting, termination, configuration, etc. information.

    a. Where project conditions dictate installation or mounting unique to the project, such installation details shall be Contractor-generated and project specific. In these instances, generic details shall not fulfil this requirement and will be rejected in their entirety and returned for resubmittal without review.
    b. Details shall include legends defining symbols, abbreviations, etc. used in the diagrams.

12. Provide for each discrete system documentation of power supply, battery charger, and battery calculations.
13. Provide for each discrete system documentation of voltage drop calculations for electrical power wiring ≥ 25 feet in length transmitting low-voltage power from system power supplies to system devices or components.
14. Provide documentation of proposed labeling scheme, to include:

    a. Logic of alphanumeric identifiers for each component type
    b. Proposed font/typeface

c. Samples of each proposed label type (e.g., cable wrap, device, control panel, etc.)

1) Samples shall be actual labeling products typical of those proposed for use on the project, including proposed font type, size, and print quality.
2) Affix each submitted proposed label type to a sheet of backing paper. Backing paper color shall provide contrast with the proposed labels to aid in making physical outline of labels clear on scanned electronic copies, and include identification of specific use each label type is proposed for (e.g., cable wrap, device, control panel, etc.).

15. Provide documentation of proposed testing procedures, to include:

a. Step-by-step description of proposed test procedure
b. Pass/fail criteria for each test
c. Sample of each proposed test result documentation format. At a minimum, test result documentation shall include:

1) Project information

a) Owner
b) Building name
c) Location
d) Project name

2) Date and time of test(s)
3) Name of the Contractor conducting the test(s)
4) Name(s) and title(s) of personnel conducting the test(s)
5) Pass/fail criteria
6) Description of sub-system tested
7) Identification of Communication Equipment Room where cable originates or location of associated system head end equipment
8) Equipment location and direction of test, where applicable
9) Test result data
10) Signature of personnel who conducted the test

d. Proposed test documentation file naming format

16. Contractor shall review prepared shop drawings internally for compliance with requirements of the project documents and make any alterations necessary to ensure compliance. Contractor shall stamp the cover page of each shop drawing section submitted to certify that this internal review was completed and necessary alterations were made to ensure compliance with requirements of the project documents prior to submitting the shop drawings for review.
17. Submittals which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
18. Engineer's Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that required items have been submitted.
19. Engineer's approval of submitted shop drawings does not relieve the Contractor from having to comply with requirements of the Contract Documents.
20. Work on site shall not proceed prior to approval of shop drawings related to that work.

C. Certificates and Inspections:

1. Deliver certificates approving installations to Owner unless otherwise directed.

a. Copies of approved shop drawings, including Owner/Engineer review and approval forms.
b. Final manufacturer's product data for each item, component, device, material, etc. that constitutes the installed system, incorporating any deviations from approved manufacturer's product data submittal and reference to project documentation that initiated the deviation.

c. Manufacturer-published installation instructions, configuration and programming instructions, owner's manuals, and operation and maintenance instructions:

1) Where manufacturer's data includes several types or models, applicable type(s) or model(s) shall be designated.
2) Include parts lists for equipment, devices, etc., including ordering and procurement information. Provide exploded parts lists where available.
3) Operation and Maintenance manuals shall not include duplicate product data within materials for a single Specification Section.

d. Documentation of firmware, software, and Ethernet network information for each IP system device, component, equipment, etc., to include:

1) Unique alphanumeric identifier
2) Location
3) Manufacturer
4) Manufacturer's part number
5) Serial number
6) Firmware version
7) MAC address
8) IP address
9) Subnet mask
10) Default gateway
11) TCP port numbers for active inbound and outbound connections
12) UDP port numbers for active inbound and outbound connections
13) Unique alphanumeric identifier of Ethernet network switch serving the device
14) Ethernet network switch port number
15) VPN assignment
16) VLAN assignment
17) Requires IP multicast functionality (yes/no)

e. Factory and field test result documentation, in format of approved test result documentation submittal.
f. Documentation of manufacturer's warranties.
g. Documentation of Contractor's warranty.

D. Record Drawings:

1. Provide final floor plans, equipment room layouts, block diagrams, and installation details incorporating any deviations from approved submittal and reference to project documentation that initiated the deviation. Documents shall include final unique alphanumeric identifiers for each item as so labeled.
2. Coordinate with Owner for designated set of contract documents to be used as a basis for record drawings.
3. Record Drawing materials shall become the property of the Owner.

E. Review and approval of submitted documents does not relieve Contractor of contractual obligations, alter work specified in the contract documents, alter requirements of the contract documents, or void requirements of the contract documents.

1.9 WARRANTY

A. Refer to technical sections for Warranty requirements specific to the work under that section.

1. The warranty period shall commence on the date of final acceptance by Owner and extend for a minimum of one (1) year.

a. Where manufacturer offers a standard warranty that extends beyond one (1) year, the published duration of the manufacturer warranty shall govern for material covered by that warranty.

2. The warranty shall guarantee work performed and materials, devices, equipment, etc. provided to be free from defect or malfunction.

B. Manufacturer's guarantees and/or warranties shall extend to the Owner.

C. Contractor shall, at Owner's sole option, repair, replace, or correct defective material and workmanship and material and workmanship that does not conform to the contract documents, at no extra cost to Owner. Contractor shall also bear costs to correct damage resulting from defective or nonconforming materials and/or workmanship.

D. Warranty does not cover defect or malfunction that is solely the result of normal wear, improper maintenance, or improper operation, as determined by the Owner/Engineer.

E. Where Contractor disturbs any work warranted under another contract while fulfilling requirements of any warranty, Contractor shall restore such disturbed work to condition satisfactory to Owner and shall warrant such restored work to same extent as it was warranted under such other contract.

F. Warranty shall include labor, material, and travel time.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide new materials, unless specifically noted otherwise in the contract documents.

B. Where manufacturer has replaced a part number with a newer part number, provide the version of the material that is the manufacturer's most current offering available at the time of installation.

C. Where manufacturer has published an end of life or similar notice for a part number, notify the Owner/Engineer of the notification and the manufacturer's recommended substitution. Where manufacturer offers no substitution, provide the Owner/Engineer three (3) options for acceptable alternates.

D. Where multiple manufacturers' names or manufacturers' names and part numbers are listed, the basis of design listed is to be considered the benchmark for quality, features, and functionality for that material.

E. Include hardware, details, options, modules, accessories, subassemblies, etc. not shown or specified, but necessary for proper installation and operation.

F. Where ≥ one (1) of the same item of material is required, all such units shall be provided as the same manufacturer and part number.

G. Refer to technical sections for additional information and requirements.

2.2 LISTING

A. Materials shall bear UL label or listing, unless UL label or listing is not available for that type of material. Where a nationally recognized testing laboratory has an applicable system listing and label, the entire system shall be so listed and labeled.

1. Other nationally recognized testing agencies acceptable to the AHJ are approved.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Refer to technical sections of this Division of work for listing requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Execute work to minimize interference, annoyance, or inconvenience such work might impose on Owner or other contractors.

B. Work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

C. Include incidental items and details that are not depicted on the drawings, required in the specifications, or specified in other contract documents but are necessary for proper installation, operation, and satisfying the scope of work and design intent conveyed.

3.2 OWNER INSPECTION

A. Owner shall, at their sole option, observe, inspect, review, and approve work in progress throughout the execution of work on site.

B. Coordinate scheduling of the following with Owner a minimum of ten (10) working days prior to commencement of the listed activity, to facilitate Owner’s observation, inspection, review, and approval of work:

1. First cable installation
2. Placement of equipment racks and cabinets, prior to final installation
3. Placement of wall-mounted equipment, prior to final installation
4. Installation of cable runway in Communication Equipment Rooms
5. First cable termination
6. First system device testing
7. Turn-over of Communication Equipment Rooms

3.3 WORK SEQUENCE

A. Coordinate schedule for execution of work performed under this section with Owner, Construction Manager, General Contractor, and other trades.

B. Disruption of Normal Operations

1. Contractor shall identify work that may disrupt Owner's normal operations or otherwise interfere with Owner's use of the premises, and coordinate with Owner and other contractors to determine which of the identified project work will disrupt operations or interfere with use of the premises. Owner shall have right of final determination on which identified project work will disrupt operations or interfere with use of the premises. Contractor shall coordinate with Owner to develop and finalize action plans to minimize and mitigate disruption of operations and interference with use of the premises.

   a. Action plans may include scheduling identified work to be executed on days and during hours outside Owner's normal days and hours of operation or on a schedule that minimizes disruption to Owner's normal operations, as defined by the Owner.

2. Contractor shall complete work sequence coordination and obtain approval of action plan and schedule by Owner and other contractors prior to the commencement of work on site.
3. Contractor shall include in their bid costs to perform disruptive and interfering work outside standard business days and hours.

3.4 DAMAGE

A. Review the site for existing damage, deleterious or unsatisfactory conditions, etc. prior to the commencement of work on site, and report to the Owner/Engineer existing damage, deleterious or unsatisfactory conditions, etc. found, including damage to structure, floors, walls, ceilings, doors, windows, furnishings, equipment, etc.

B. Commencement of work on site indicates Contractor's acceptance of existing conditions. Contractor shall be solely responsible for costs to correct damage or deleterious conditions found in the project area that went unreported prior to the Contractor's commencement of work on site.

C. Contractor shall replace accessible ceiling tiles damaged during the execution of work under this section. Replacement tiles provided shall match manufacturer, part number, size, style, color, texture, etc. of damaged tiles.

3.5 CONTINUITY OF SERVICES

A. No service shall be interrupted, changed, or terminated without written permission from Owner and Owner/Engineer. Obtain written permission prior to commencement of work that may affect services.

B. When work under this section may interrupt services, or when services need to be interrupted as part of execution of work under this section, Contractor shall notify Owner/Engineer, and other affected parties a minimum of four (4) weeks prior to commencement of work affecting services and coordinate a mutually-agreed-upon schedule for completing that work.

3.6 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle materials in a manner that avoids damage, preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties.

   1. Where applicable, lift only with lugs provided for the purpose.

B. Maintain manufacturer's original material packaging and shipping packaging until material is installed.

C. Store materials in a clean, dry, secure, temperature-controlled location in a manner that preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties. Protect stored material from deleterious substances, agents, conditions, etc. including dust, dirt, debris, moisture, chemicals, chemical compounds, corrosion, temperatures outside material's published tolerance range, etc. and from damage due to intentional or incidental contact, vandalism, neglect, etc.

D. Contractor shall include in their bid costs to deliver, store, and handle materials.

3.7 LOCATIONS OF WORK

A. Field-verify locations, elevations, measurements, etc. prior to installation of materials.

B. Electronic Safety and Security equipment and device locations shown on drawings are diagrammatic and shall not be used for dimensioning of final location. Field-coordinate locations, elevations, measurements, etc. with Owner and with other trades prior to installation of materials.

1. Where architectural features govern location of work and where areas are dense with work of multiple trades, refer to Architectural contract documents. Where work by other trades governs location of work, refer to the contract documents of the other trade. Check, verify, and coordinate work with other trades' contract documents and include modifications, relocations, adjustments, etc. necessary to complete work and prevent interference with other trades.
2. Included in this contract are connections to equipment provided by others. Refer to other trades' contract documents, including Architectural, Electrical, Technology, and to final shop drawings for equipment being furnished under other sections for exact locations of equipment, devices, etc. and of various connections required.

C. Locate equipment, devices, etc. to fit details, panels, decorating, finish, etc. at space. Owner reserves the right to make minor position changes of equipment, device, etc. locations before work has been installed.

D. Contractor shall survey the site and include in their bid costs to perform work as specified in the contract documents.

E. Where conditions on site require adjustments to indicated locations and/or arrangements of equipment, devices, etc., Contractor shall make required changes at no additional cost to the Owner.

3.8 CUTTING AND PATCHING

A. Refer to General Conditions of Contract for additional information and requirements.

B. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore damaged work to original condition, including openings remaining from removal or relocation of existing system components.

C. Repair damage to walls, floors, ceilings, fixtures, furnishings, etc. caused by installation of work under this section. Repairs must match preexisting condition, color, finish, etc. of walls, floors, ceilings, fixtures, furnishings, etc.

D. Provide materials required for patching and repair, unless otherwise noted.

E. Do not pierce beams or columns without permission of Owner and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

F. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

3.9 FLOOR, WALL, ROOF, AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with work by other trades.

B. Size and location of openings, chases, holes, etc. shall be reviewed and approved by Structural Engineer prior to execution.

C. X-ray reinforced concrete floors to identify actual locations of embedded reinforcing elements prior to making openings, chases, holes, etc. and adjust size and location of openings, chases, holes, etc. to avoid embedded reinforcing elements.

D. Openings for penetrations shall be ≥1/2” larger on all sides than the outside dimensions of the raceways and shall have ≥ 2” clearance around the openings. Where fire resistant penetrations are required, size openings in accordance with published UL assembly being installed and with firestopping system manufacturer’s published recommendations.

E. Provide sleeves, inserts, etc. that are to be built into structure in a timely manner during progress of construction to prevent delay of work.

F. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

G. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

H. Circular openings, chases, holes, etc. through finished concrete or masonry shall be made by core drilling. Rectangular or square openings, chases, holes, etc. through finished concrete or masonry shall be made by concrete saw. Impact hammer, manual chisel, etc. shall not be used.

I. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

J. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

K. Seal non-rated wall openings with urethane caulk.

L. Adhesives and sealants used on the interior of the building shall comply with VOC limits per LEED requirements.

M. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Owner. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

N. Finish and trim penetrations as shown on details and as specified hereinafter.

O. Provide escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

1. Coordinate color and finish of escutcheons with Owner. Escutcheons shall be chrome or nickel plated unless otherwise directed.
2. Penetrations other than conduits (junction boxes, light fixtures, etc.) including wiring devices shall be sealed as follows:

a. Seal non-rated opening with silicone sealant.
b. Refer to drawings for details.
c. Confirm selected sealant is compatible with paint provided by others prior to application.
d. Product: One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substances indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:

1) 786 Mildew Resistant Silicone Sealant; Dow Corning Corp.
2) Sanitary 1700 Silicone Sealant; General Electric Co.
3) 898 Silicone Sanitary Sealant; Pecora Corp.
4) Tremsil 600; Tremco Corp.
5) OmniPlus; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

P. Wherever installation of this Contractor's equipment destroys sound transmission class (STC) rating integrity of wall, floor, or ceiling, this Contractor shall bear the cost of repair to restore that integrity. Coordinate these requirements with General Contractor.

3.10 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance after completion of project. Contractor shall relocate raceways or accessories as required to provide access at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair, or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Verify room door swings before installing equipment, devices, etc. and install such equipment, device, etc. back boxes on latch side of door unless otherwise noted.

D. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs, or maintenance is located in walls or chases or above inaccessible ceilings.

1. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, minimum sizes, and rough-in dimensions, without limitations.

3.11 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide, or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.12 SUPPORT PROTECTION

A. In occupied areas, electrical rooms, mechanical rooms, utility areas, and areas requiring normal maintenance access, equipment must be guarded to protect personnel from injury.

B. Provide minimum 13 mm(1/2") thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 2.1 m(7 ft.) above floors, platforms, or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.13 INSTALLATION

A. Pre-Installation Inspection

1. Prior to commencement of work on site, Contractor shall inspect the site to evaluate whether site conditions are sufficiently consistent with the Contract Documents to support and facilitate execution of specified work and specified system performance.
2. Contractor shall prepare and submit to the Owner a report documenting observed inconsistencies that may impact execution of specified work or specified system performance. Report shall include photographs, annotated drawings, written descriptions, etc. to clearly and completely document observed inconsistencies, and itemized recommendations and cost estimates for remediation of each observed inconsistency.

   a. Contractor shall not take any steps to remediate observed inconsistencies without written direction from the Owner.

3. Commencement of work on site indicates Contractor's confirmation that existing conditions support and facilitate execution of specified work and specified system performance. Contractor shall be solely responsible for costs to remediate inconsistencies that went unreported prior to the Contractor's commencement of work on site.

B. General

1. Refer to manufacturer's product installation instructions, recommendations, and guidelines for additional information and requirements. Wherever a discrepancy is identified between Contract Documents and manufacturer's product installation instructions, the more stringent requirement shall govern.
2. Cable, devices, equipment, etc. shall not be installed until building is enclosed and weather tight, and temperature and humidity conditions are controlled continuously at levels approximately equivalent to final conditions expected after occupancy.
3. Cable, devices, equipment, etc. shall not be installed in areas where installed materials would be exposed to moisture, dust, overspray, or other deleterious conditions.
4. No equipment, devices, cable, etc. shall be installed in Communications Equipment Rooms until room is broom clean and free of debris, dirt, dust, moisture, foreign materials, etc. and room is equipped with operable door that can be closed and latched to prevent ingress of deleterious conditions.

5. Protect installed cable, devices, equipment, etc. from damage through completion of construction and date of Owner's final acceptance.

C. Rough-In

1. Coordinate back box, plaster ring, raceway, surface raceway, cable tray, etc. pathway requirements with Division 26 prior to the commencement of work on site.
2. Where Division 28 equipment or device is provided with an equipment- or device-specific back box, Contractor shall provide that back box to Division 26 prior to commencement of rough-in work on site.

D. Cable and Conductors

1. Cable shall be listed for installation in the environment in which it is installed.
2. No cable or conductor shall be fished bare through the interior of any enclosed, inaccessible ceiling, wall, or floor structures. Where such installation is required, fish flexible metallic conduit through the structure, secure the flexible metallic conduit at both ends and provide protective bushings at both ends of it, and install cable inside flexible metallic conduit.
3. Install cabling in pathways provided, or as designated on floor plans, and support from building structure.
   a. Where installed in free-air, support cables using J-hook type cable supports.
      1) J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed.
      2) Route cable/hooks at right angles, parallel to construction.
   b. Where installed in Cable Tray, lay cables neatly in tray.
      1) Do not tie.
      2) Provide sufficient slack in cables to allow for unequal expansion coefficients of cable tray and cables. This requirement is in addition to slack required at cable tray expansion joints.
4. Provide pull cord (200 lb. minimum) with cable installed in conduit.
5. Cable and conductors installed shall be free of defects and damage. Provide required installation tools to facilitate cable and conductor installation without damaging the cable and protect cable and conductors from damage. Visually inspect cable during installation for damage or defects, including cuts, blisters, abrasions, etc. Provide permanent abrasion protection at points where cable or conductors contact surface that could damage the cable or conductors.
6. Pull cable by hand unless installation conditions require mechanical assistance.
7. Do not exceed recommended pulling tensions or bending radii during cable installation.
   a. Replace cables bent or kinked to radius less than recommended dimension.
8. Pulling lubricant may be used and shall:
   a. Be non-injurious to cable jacket and other materials used.
   b. Not harden or become adhesive with age.
9. Cable and conductors shall be installed continuous and splice-free.
10. Maintain manufacturer's published minimum bend radius on installed cable and conductors. Provide permanent bend radius protection at points where cable and conductors change direction.
11. Unless noted otherwise, install cable and conductors parallel and perpendicular to major building lines.
12. Cable and conductors shall be kept clear of and protected from work by other trades.
13. No cable or conductor shall be attached to or supported in any manner by work by other trades.
14. No cable or conductor shall be laid on accessible ceiling grid or tiles, or attached or supported in any manner by accessible ceiling tiles, grid, or support wires.

15. In vertical pathway, support cables on each floor using industry recognized support methods designed specifically for that purpose.
    a. Strap vertical runs as required to prevent sagging of cables.
16. Route and support cable in Equipment Rooms utilizing horizontal overhead cable runway, wall-mounted vertical cable runway, and wall-mounted "D-type" mounting rings.
17. Neatly lace, dress, and support cabling and conductors.
18. To reduce effects of EMI, adhere to the following minimum cable separation distances defined in TIA-569-C.
    a. 24” from power lines of 2 kVA
    b. 18” from high voltage lighting (including fluorescent and LED)
        1) When using LED lighting, stated separation distance shall be from cables to LED drivers.
    c. 48” from power lines of 5 kVA or greater
    d. 48” from transformers and motors

E. Termination

1. Install and tighten connectors per manufacturer’s instructions, using the appropriate tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, equipment, devices, etc. by over-tightening terminations.
2. Cable and conductor color coding shall be maintained consistent throughout the installation for each equipment and device type.
3. Provide ≥ 12 inches of slack at system equipment and devices, for future re-termination.

F. Equipment

1. Unless noted otherwise, install wall mounted equipment in Equipment Rooms between +18” AFF and +72” AFF.

G. Configuration and Programming

1. Coordinate configuration and programming with Owner prior to the commencement of configuration and programming work.
2. Change logins and passwords from manufacturer defaults upon first system startup, prior to the commencement of configuration or programming work. Coordinate logins with Owner prior to the commencement of configuration or programming work. Passwords used during execution of installation, configuration, programming, testing, commissioning, etc. work shall:
    a. Consist of a minimum of eight (8) printable ASCII characters
    b. Include at least one of each of the following:
        1) Capital letters
        2) Lower case letters
        3) Numbers
        4) Special characters
3. Upon system turnover to Owner, change passwords to Owner-defined passwords. Coordinate passwords with Owner prior to system turnover.

3.14 PAINTING

A. Equipment and Devices

1. Unless specified otherwise, furnish equipment with factory applied prime finish.

2. Where factory finish on equipment provided by Contractor is damaged prior to Owner's final acceptance, refinish equipment per manufacturer's instructions and guidelines to satisfaction of Owner.
3. Furnish to Owner one (1) can of manufacturer's touch up paint for each factory finish of Contractor-provided material.

3.15 CABLE AND CONDUCTOR PROTECTION

A. Protect equipment, devices, termination components, cables, conductors, etc. from contact with, and potential application of, foreign materials.

1. For the purposes of this Section, foreign material is defined as material or compound that is not part of equipment, devices, termination components, cable assembly, conductor, etc. when delivered from manufacturer.

a. Examples include concrete, mortar, drywall compound, primer, paint, stain, polyurethane, varnish, spray foam insulation, and spray-applied fire resistive material.

B. Replace equipment, devices, termination components, cables, conductors, etc. that come into contact with foreign materials, at no cost to project.

C. No solvents, chemicals, compounds, or agents shall be used to remove foreign materials that have accumulated on equipment, devices, termination components, cables, conductors, etc.

3.16 START-UP

A. Systems and equipment shall be started, adjusted, tested, etc. and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Where specified, provide at no additional cost to Owner the services of manufacturer's personnel for start-up, adjustment, and checkout of systems and equipment provided.

C. Provide the services of a manufacturer-trained and -certified technician who is knowledgeable in the start-up, adjustment, and checkout of the types of systems and equipment provided and is experienced with the specific materials provided.

1. Where Contractor does not employ such a technician directly on their own staff, Contractor shall provide at no additional cost to Owner such services from manufacturer's personnel.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Follow manufacturer's pre-start-up checkout, start-up, adjustment, and troubleshooting procedures.

F. Coordinate start-up with Owner and other trades.

3.17 DOCUMENTATION

A. Refer to 280000 - 1.10 - Submittals for additional information and requirements.

B. Refer to technical sections for additional information and requirements.

C. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

1. Operation and Maintenance Documents
2. Record Drawings

D. Within five (5) working days of completion of each testing phase (e.g., building, area, floor, section, subsystem, cable type, etc.), Contractor shall submit draft record drawings and draft test result documentation for that testing phase.

1. Draft record drawings may include legible hand-written markings of actual device locations and unique alphanumeric identifiers as so labeled.

E. Submit final versions of System Documentation within thirty (30) calendar days of completion of last testing phase (e.g., building, area, floor, section, subsystem, cable type, etc.).

3.18 CLEANING

A. Refer to individual technical sections for additional information and requirements specific to work under that section.

B. Contractor shall, periodically, throughout execution of work under this section and/or as directed by Owner, Construction Manager, or General Contractor, remove waste materials, trash, rubbish, debris, etc. generated by execution of work under this section from building and leave work areas broom clean.

C. After installation is complete and prior to Owner's final acceptance, Contractor shall clean work provided under this section.

1. Remove unused materials, tools, installation equipment, etc. from the site.
2. Faceplates, devices, components, equipment, enclosures, junction boxes, pull boxes, etc. shall be clean and free of stains, dust, dirt, debris, oil, grease, paint, and any other foreign material.
3. The interiors of equipment enclosures, junction boxes, pull boxes, etc. shall be clean and free of wire/cable scraps, pieces of wire/cable insulation, stains, dust, dirt, debris, oil, grease, paint, and any other foreign material.
4. Remove temporary labels not used for instruction or operation.
5. Walls and floors of Electronic Safety and Security spaces and equipment rooms shall be clean and free of dust, dirt, debris, oil, grease, paint, and any other foreign material.
6. Remove and properly dispose of waste materials, trash, rubbish, debris, etc. generated by execution of work under this section.
7. Contractor's cleaning protocol shall not damage provided materials in any way, or invalidate the manufacturer's warranty on provided materials.

    a. Contractor's cleaning protocol shall only include methods and use of solvents, chemicals, compounds, and agents approved by the material manufacturer for use on their product.

END OF SECTION 280000

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

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. RS-485 cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 271000 - Structured Cabling
2. Section 271100 - Communications Equipment Room Fittings
3. Section 271500 - Communications Horizontal Cabling

B. Related Division 28 Sections include:

1. Section 280000 - General Electronic Safety and Security Requirements
2. Section 281300 - Access Control
3. Section 282300 - Video Surveillance System

C. Refer to UNCW Standards for further information.

1.4 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. UTP: Unshielded twisted pair.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Operation and Maintenance Data: For wire and cable to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Allowable pulling tension of cable.
2. Cable connectors and terminations recommended by the manufacturer.

1.6 QUALITY ASSURANCE

A. 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.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

PART 2 - PRODUCTS

2.1 Horizontal cabling and hardware

A. Refer to 27 series specifications

2.2 ELECTRONIC ACCESS CONTROL CABLE

A. General

1. Refer to manufacturer’s published product installation instructions for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer’s published product installation instructions, the more stringent requirement shall govern.
2. Cable shall be plenum or riser rated as dictated by the environment in which the cable is installed.
3. Cable installed in wet or damp locations, including, but not limited to, in-slab and buried conduit, shall be rated for installation in wet locations.

B. Intelligent System Controller Cable

1. Ethernet Cable

a. 4-pair UTP

1) Refer to Section 271500 for information and requirements.
2) Ethernet cable patch panel by Division 27. Refer to Section 271500 for additional information.

2. Ethernet Patch Cables

a. 4-pair UTP

1) Refer to Section 271500 for information and requirements.

3. RS-485 Cable

2.3 Refer to Section 281300 and 282300 for information and requirements.

2.4 CONTROL-CIRCUIT CONDUCTORS

1. Refer to Section 281300 and 282300 for information and requirements.

2.5 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 Electrical Systems Identification.

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.2 WIRING METHOD

A. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion 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.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. 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.
2. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
3. 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.
4. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
5. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation: Refer to 27 series specifications

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inchesabove ceilings by cable supports not more than 60 inchesapart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. Minimum Conductor Sizes:

1. Refer to Section 281300 and 282300 for information and requirements.

3.5 CONNECTIONS

A. Comply with requirements in Section 281300 Access Control for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Section 282300 Video Surveillance for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Refer to Section 26 0593 - Electrical Systems Firestopping

3.7 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 Electrical Systems Identification.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Refer to Section 271500 for information and requirements for testing of 4-pair UTP cabling.

C. Tests and Inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.
2. 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.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 281300 - ACCESS CONTROL

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. The purpose of this document is to define the standards and procedures for the installation of access control equipment, electronic locks, cables, wire and all ancillary equipment on the campus of the University of North Carolina at Wilmington (UNCW) and all properties owned or leased by the university. The integrity of all equipment, cabling and proper installation is essential to the University's commitment to providing a safe and secure environment for students, faculty, staff and visitors of UNCW. These standards and procedures shall be reviewed and updated regularly to ensure they are up-to-date and accurate. All standards and procedures in this document shall be compliant with all relevant laws or directives set forth by the Federal Government, the State of North Carolina, The University of North Carolina System and the University of North Carolina at Wilmington. UNCW Physical Security and Access reserves the right to hire an outside contractor to perform electronic control equipment installation upon the review of the scope of the job and the timeframe necessary to complete the project. In addition, the overall costs associated with the equipment installation (i.e. labor) shall bear weight into the final decision of using contracted services versus UNCW Physical Security and Access.

B. All Access Control Installations shall conform to the Americans with Disabilities Act and any other applicable local, state or federal regulations and must adhere to state and local fire code for life safety.

C. Cables and wiring shall conform to the standards set by UNCW ITS-NetCom and the solution installed in the building.

D. All Access Control door hardware shall be approved for use at UNCW. Any necessary changes will require approval from UNCW Physical Security and Access.

E. All equipment must be compatible with the Lenel OnGuard Access Control system.

F. All new and retro construction requiring Access Control shall use wired control devices. No wireless devices shall be installed on any door without prior authorization from UNCW Physical Security and Access

G. All Access Control equipment must come to the UNCW Physical Security and Access office prior to installation.

1.3 STANDARDS

A. Door locksets shall be either:

1. Best electric mortise lock with request to exit and internal deadbolt switch with indicator for internal doors
2. Von Duprin panic device with low current request to exit switch for internal or external door
3. Best electric mortise lock with request to exit and the storeroom function for instances which require a mortise lock for external doors.

4. All locksets shall be approved by a UNCW Locksmith and UNCW Physical Security Access. (Part Numbers are included in the approved parts list of this document)

B. Interior doors shall conform to a mortise lockset. Exterior doors shall conform to a panic device lockset. Electric strikes and Magnetic locks are NOT acceptable. All other configurations require approval from UNCW Locksmith and UNCW Physical Security and Access.

C. Card access equipment MUST be provided by an approved UNCW Certified Lenel VAR and the VAR must be approved by UNCW Physical Security and Access. Installation and wiring of all access control equipment MUST be performed by Lenel Certified technicians. Physical Security and Access MUST approve any equipment changes.

D. Power supplies for all electric locksets shall be Von Duprin model PS914-4RL. Power Supplies must be mounted in a secure space and shall NOT be installed above doors or ceilings.

E. Hinges for all card system doors shall be Hager hinge model BB1199 or BB1191 ETW-8 (or an approved equivalent) or Select continuous hinges with service panel and eight (8) through wires. Prep work of doorframe will be the responsibility of General Contractor. At grout filled frames, a mortar box (Example: Hager #430), shall be furnished for each electrified hinge and shall be furnished to the Hollow Metal Frame supplier for installation on the frame prior to the frame being shipped to the project site.

F. The preferred first choice of door monitoring shall be a magnetic ¾-inch diameter door position switch, such as a GE Security 1078C series or equivalent. On double doors where each leaf has a DPS, the devices shall be wired in series. Both sensors shall report alarms to the system as a single alarm point.

G. Doors with a 3-hinge configuration shall have the middle hinge being the electrified hinge. Doors with a 4-hinge configuration shall have the lower middle hinge being the electrified hinge. Hinge height should be 39” to 40” to top of hinge. Panic device electrified hinges shall be as close to even with the panic device as allowable for proper wire length from electrified hinge.

H. Interior doors specified with card access and furnished with an electrified mortise lock shall contain a temperature control module built into the lockset or shall have a temperature control module provided with the lockset.

I. Doors requiring a panic device shall include QEL electric latch retraction and low current request to exit switch.

J. ADA openers require a control cable, as specified in the door control section of this document, run from ADA opener to lock power supply, to be installed by the Contractor. Each ADA button shall be hardwired and installed on the right-side entry of doorway above or below the access control reader.

K. All Access Control Doors MUST include a door closer that conforms to all UNCW door hardware standards unless otherwise approved by UNCW PSA.

L. The Von Duprin CHEXIT Delayed Egress System is NOT authorized by UNCW PSA for use with the campus Access Control System. If installed, PSA will NOT support this hardware to include inspections or service.

1.4 RESPONSIBILITIES

A. UNCW

1. UNCW Physical Security and Access department shall oversee installation and maintain all Lenel and access control equipment as well as provide the department requesting Access Control with an

estimate for the necessary Lenel and ancillary equipment. UNCW shall provide all network equipment to include network switches. The UNCW Network Data Analyst shall assign any necessary switches, ports and IP addresses. UNCW Physical Security and Access shall be responsible for setting up Status Levels, Door Schedules and assigning Access as appropriate. The UNCW Network Infrastructure Analyst shall monitor the installation of wires and cables to ensure that all UNCW ITS-NetCom Department standards are satisfied. The UNCW Project Manager shall provide "As Built" drawings to the UNCW Physical Security and Access department where applicable.

B. Contractors

1. The contractor shall ensure that they are operating in compliance with any North Carolina General Statutes that may be applicable to performing any part of their duties. The contractor shall provide and pull all required low voltage power and data cabling as well as ground wire as required. The contractor shall provide power supplies; install all conduits and any other necessary door hardware or other materials to complete the installation. All equipment shall be in accordance with UNCW Physical Security and Access Standards and UNCW standards for door hardware. Any substitutions must be submitted to the UNCW Physical Security and Access manager for approval or the Physical Plant as appropriate. The contractor shall provide materials and electricians if additional 120 VAC services are required. The contractor shall label all cables and wires to allow for UNCW Physical Security and Access personnel to identify the location and purpose of each cable or wire. The contractor shall install all panels, power supplies and other electronic equipment associated with the Access Control System. The termination of all wires and cables shall be in accordance with the guidelines set forth in this document.

C. Splicing of wires and conductors shall NOT be permitted.

D. All lock power connections shall be made using solder and heat shrink tubing. Wire nuts and other such connectors shall not be permitted.

E. Connections at transfer hinges, readers, and other equipment other than lock power shall be made using 3M Scotchlok UY2 connectors or similar connectors in lieu of solder and heat shrink tubing, Wire nuts are not permitted.

F. Spare conductors in cables shall not be eliminated. Cut the spare conductors to the same length as the conductors in use and wrap them around the cable jacket for future use.

G. Cable, wires and conductors shall be cut so that a reasonable length is left for future service. There shall be proper cable management of all wires, cables and cords in the Security room, in Lenel panels and lock power supplies. Cable grommets shall be used to route wires and cables into panels, cabinets and junction boxes.

H. The wiring color codes provided in this document shall be used when possible. UNCW Physical Security and Access must approve changes.

I. All Power Cords in the Security Room shall be plugged into a surge protector power strip. If panels and power supplies are hardwired, then light switches shall be used to turn off power to each panel and power supply.

J. All panels and power supplies shall be labeled so that service technicians can easily identify the location of readers, lock power, inputs and outputs.

K. Power tools shall NOT be used when installing soft, metal screws in door hardware.

L. Section Includes:

1. One or more intelligent controllers
2. One or more I/O controllers
3. Security access controllers connected to high-speed electronic-data transmission network.
4. Power supplies for electric strikes and locks
5. Power supplies for access control system intelligent controllers an I/O controllers.
6. Electrical connections
7. Wire and cable
8. Request to Exit devices
9. Door Position Switches

M. Related Work:

1. Electric Door Locks, Electric Door Switches and integral request-to-exit by Division 8.
2. Elevator controls, including control wiring between the elevator control terminal (Access Control System) and elevator controller, Division 14.
3. Structured Cabling, Division 27
4. TCP/IP Routers and Switches, by Owner.

1.5 CODES AND STANDARDS

A. Refer to Section 280000 - General Electronic Safety And Security Requirements, for applicable codes.

B. The system shall be listed by Underwriters' Laboratories, Inc., for meeting the requirements of UL-294, "Standards for Access Control System Control Units".

1.6 DEFINITIONS

A. Auxiliary Intelligent Controllers (AIX) or Auxiliary I/O Controllers (AIO). Controllers that are located near a served access control door and not in the Master Intelligent Controller Location.

B. CCTV: Closed-circuit television.

C. CPU: Central processing unit.

D. Credential: Data assigned to an entity and used to identify that entity.

E. GFI: Ground fault interrupter.

F. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

G. Intelligent Controller: An access control controller containing a database of cardholders and system operation parameters that allow it to operate independently from the system Server when the communications between the Server and the Intelligent Controller is not available.

H. I/O controllers: Input/Output controllers that provide a wiring interface to field devices,

I. LAN: Local area network.

J. Master Intelligent Controller (MIC). An intelligent controller that connects to Auxiliary Intelligent Controllers or Auxiliary I/O controllers I/O controllers over TCP/IP or EIA-485 communications networks.

K. MIC Location: Dedicated wall or rack-based space for location of a Master Intelligent Controller and associated Auxiliary Intelligent Controllers, Auxiliary I/O controllers, Lock and System Power Supplies, and Batteries.

L. Location: A Location in the building having a Master or Auxiliary Intelligent Controller. Where this term is presented with an initial capital letter, this definition applies.

M. PC: Personal computer. Applies to the main and auxiliary workstations.

N. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

O. Proximity Card: Magnetic principle that uses specially treated wires embedded in the credential card.

P. RAS: Remote access services.

Q. RF: Radio frequency.

R. ROM: Read-only memory. ROM data are maintained through losses of power.

S. Server: Computer configured as an access control system application and file server.

T. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

U. UPS: Uninterruptible power supply.

V. USB: Universal serial bus.

W. WAN: Wide area network.

X. WAV: The digital audio format used in Microsoft Windows.

Y. WMP: Windows media player.

Z. Wiegand: Cable and signal protocol

AA. Windows: Operating system by Microsoft Corporation.

BB. Workstation: A PC with software that is configured for specific, limited security-system functions.

1.7 SUBMITTALS

A. Product data Section 280500 - Common Work Results For Electronic Safety and Security including but not limited to:

1. Central Control Unit Historical Data Log Equipment
2. Elevator Control Interface Printer
3. Card Readers Control Relays
4. Cards Control Wiring

B. Shop Drawings

1. Floor Plans: Prepare CAD based shop drawings to show device locations, raceway routing and sizes, and color-coded wiring between devices.

2. Riser. Provide diagram showing vertical wiring between components.
3. Control Schematics. Provide a control schematic showing interface circuits for each piece of equipment, termination and connection diagrams including wire numbers.
4. Recessed Mounted Card Reader. Provide card reader cut out size and mounting information to the appropriate subcontractor.
5. Elevator Card Reader. Provide elevator card reader cut out size and mounting information, elevator wiring data and elevator control unit to elevator subcontractor.
6. Release of CAD Files: Contractor may request to utilize CAD files for assistance in producing shop drawings.
7. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
    a. Controllers.
    b. Entry credential readers/keypads and electrical door hardware.
    c. Duress buttons.
    d. Interface to:
        1) Fire alarm system
        2) CCTV System.
        3) Elevator Controllers.
        4) Emergency Phones.
8. Cable Administration Drawings: As specified in "Identification" Article.
9. Battery and charger calculations for controllers and I/O modules.

1.8 CONTRACT DRAWINGS

A. The contract drawings indicate the general nature of the system layout, but do not show all components required. Raceways, routing and wiring are not shown on the drawings. Contractor shall provide per system requirements and shop drawings.

B. Contractor shall coordinate outlet box requirements with system supplier. Notify Architect prior to installation if conflicts occur between required box depth and wall thickness.

1.9 QUALITY ASSURANCE

A. Supplier and/or subcontractor shall:
1. Have been in the business of installing and maintaining the specific type of system equipment under the present firm name for at least five years.
2. Have been distributing and/or installing the specific brand and model line of system equipment for at least three years prior to the date on the contract documents.
3. Have the capability of having on-site a maintenance or repair truck with a qualified repairman within four (4) hours of a request for service on the equipment.
4. Each supplier and/or subcontractor's staff responsible for the following activities shall have a manufacturer's training certificate specifically endorsed for the particular activity:
    a. Shop Drawing preparation
    b. Cable installation
    c. Cable termination
    d. Device mounting and cable termination.
    e. Controller and peripheral commissioning
    f. Software installation and commissioning.
    g. Application software configuration.

B. Source Limitations: Obtain workstations through one source from a single manufacturer. Obtain controllers and all software through one source from single manufacturer.

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.

D. Comply with NFPA 70, "National Electrical Code."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Server, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.11 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, Type 4enclosures. System components installed in non-air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

1.12 EXTRA MATERIALS

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 of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment

1. The equipment manufacturers and model numbers specified herein are meant to provide a standard of quality. It is the responsibility of the bidder to ensure that his proposed product meets or exceeds the quality and performance of the specified model and compatible with other identified systems.

2.2 DESCRIPTION

A. Security Access System: PC-based Client Server, one or more networked PC-based workstations and field-installed controllers, connected by a high-speed electronic-data transmission network.

B. System utilizes a TCP/IP-based LAN and/or WAN network to connect the servers, Master Intelligent Controllers, and workstations. The system shall utilize the following LAN-based network:

1. Local area, IEEE 802.3 Fast Ethernet/Gigabit-Ethernet star topology network based on TCP/IP

C. System shall utilize the LAN network to interconnect the Master Intelligent Controller to the remaining controllers served by MIC.

D. A network data drop is required at the main Lenel communications panel (UNCW will designate a network port). Additional Lenel door access panels in other areas of the building require a 2 pair 22 awg stranded cable or a CAT6 cable to the main Lenel Communications panel. The maximum distance shall be 1000 feet unless a Lenel 8000 multiplexer is installed increasing the distance to 4000 feet.

2.3 OPERATION

A. Security access system shall use single database for access-control and credential-creation functions.

B. Distributed Processing: A fully distributed processing system.

1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to intelligent controllers so each controller can make access-control decisions.
2. Intermediate controllers for access control are prohibited.
3. In the event that communications with the central controller are lost, intelligent controllers shall automatically buffer event transactions until communications are restored and server shall buffer system configuration changes, at which time buffered events shall be downloaded to the intelligent controller uploaded to the server.

C. Field equipment shall include intelligent controllers I/O controllers, sensors, and controls.

1. Controllers shall serve as an interface between the primary operator's station and sensors and controls.
2. Data exchange between the primary operator's station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
3. The up-line data exchange from the controller to the primary operator's station shall include status data such as intrusion alarms, event alarms, status reports, and entry-control records.
4. Controllers are classified as alarm-annunciation or entry-control type.

D. System Response to Alarms:

1. Field device network shall provide a system end-to-end response time of one second or less for every device connected to the system.
2. Alarms shall be annunciated at the primary operator's station within one second of the alarm occurring at a controller or at a device controlled by a local controller, and within 100 ms if the alarm occurs at the primary operator's station.
3. Alarm and status changes shall be displayed within 100 ms after receipt of data by the primary operator's station.
4. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
5. This response time shall be maintained during system heavy load.

E. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.

F. Door Hardware Interface:

1. Comply with requirements in Division 08 Sections for door hardware required to be monitored or controlled by the security access system.
2. Electrical characteristics of I/O controllers shall match the signal and power requirements of door hardware.

2.4 APPLICATION SOFTWARE

A. Licenses: The System shall be provided with all software licenses necessary to operate the system. Install software on workstations as directed by Owner.

B. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.

   a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
   b. Controllers shall be part of a fully distributed processing-control network.
   c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.

2. The following functions shall be fully implemented and operational within each controller:

   a. Monitoring inputs.
   b. Controlling outputs.
   c. Automatically reporting alarms to the server.
   d. Reporting of sensor and output status to the server on request.
   e. Maintaining real time, automatically updated by the server at least once a day.
   f. Communicating with the server.
   g. Executing controller resident programs.
   h. Diagnosing.
   i. Downloading and uploading data to and from the server.

3. Controller Operations at a Location:

   a. Up to 64 AIC controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers serving the same secure perimeter without server or workstation intervention. Linking and anti-passback shall remain fully functional within the same secure perimeter even when the primary operator's station or workstations are off-line.

b. In the event of communication failure between the server and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
c. Buffered events shall be handled in a first-in-first-out mode of operation.

4. Individual Controller Operation:

a. Controllers shall transmit alarms, status changes, and other data to the server when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the server, shall be stored for later transmission to the server. Storage capacity for the latest 1024 events shall be provided at each controller.
b. Card-reader ports of a controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
d. Controllers that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the server.

5. Communications Monitoring:

a. System shall monitor and report status of communications loop of each Location.
b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.
c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

C. PC-to-Controller Communications:

1. Server or workstation communications shall use the following:

a. Direct connection using serial ports of the PC only where indicated on Plans.
b. TCP/IP LAN interface cards.

2. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.
3. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.

4. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.
5. PC-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered and retransmitted if not acknowledged.

D. TCP/IP PC-to-Controller Communications:

1. Communication software on the PC shall supervise the PC-to-controller communications link.
2. Loss of communications to any controller shall result in an alarm at all PCs running the communication software.
3. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the controller.

E. Master controller-to-Auxiliary Controller Communications: TCP/IP

F. Database Downloads:

1. All data transmissions from PCs to controllers, and between controllers, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
2. If a controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.
3. Software shall provide for setting delays of database downloads for dial-up connections. Delays change the download from immediately to a delay ranging from one to 999 minutes.

G. Partitioning

1. This contractor shall be responsible for partitioning the access control system for the card readers and equipment located within the hotel. Coordinate with Kemper Development for exact demarcation.
2. The system shall employ advanced database segmentation functionality. Each segment shall be allowed to have its own unique set of hardware and system parameters including access control field hardware, time zones, access levels, etc. This shall provide a “segment/landlord” architecture to object records in the system, where segment System Administrators and Operators can only view, add, modify, delete, and manipulate system parameters and access control field hardware that belong to their respective segments. Landlord Administrators shall have complete control over the entire system.

H. Alarms:

1. Fire alarm interface

   a. Provide interface to fire alarm system to allow required exiting during times of a fire alarm. Fire alarm interface shall allow free egress unless door delayed egress has been provided.

2. Emergency Ring-Down Phone interface

   a. Provide alarm inputs for site emergency ring-down phone call buttons.

3. Duress Button Interface

   a. Provide alarm inputs for each duress button, or each wireless duress system.

4. CCTV Alarm Interface: Allow commands to be sent to CCTV systems during alarms (or input change of state) through serial ports.

5. CCTV Integration: The system shall be capable of automated control via an interface with the Closed Circuit Television (CCTV) System. When the system receives an alarm from any monitoring point connected to the system, the system shall:

   a. Activate a recording device to begin real-time recording of the area in alarm for up to four cameras.
   b. Create a link between the Access Control System alarm database and the recording system database to cause the recording to be permanently associated with the alarm and available for re-viewing through the alarm log.

      1) Upon “selecting” or review of the alarm by the System Operator at the alarm monitoring workstation:
      2) Shall be used to call-up the camera(s) to view the alarm area when the System Operator chooses the alarm for acknowledgment.
      3) Shall allow the Operator to extract and save the video recording associated with the alarm to any file system on the Network.
      4) Upon alarm acknowledgment or clearing the alarm:
      5) Shall allow the camera, monitor, and recording device to be set back to reset positions or normal operation automatically.

   c. Monitoring points shall include inputs from:

      1) Door switches
      2) Duress Buttons
      3) Emergency ring-down phones
      4) CCTV system

   d. Allow commands to be sent to CCTV system during alarms via software integration over the LAN/WAN.
   e. Camera Control: Provide operator ability to select, view, and control cameras from graphic maps.

6. Manufacturer: Lenel Integrated Access Control

2.5 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

   1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits." as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on ALL enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.6 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the server or workstation for controlling its operation.

B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

C. Battery Backup: Sealed lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation (I/O) Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network, with dc line supervision on each of its alarm inputs.

a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
b. Outputs: Managed by central-station software.

2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.

E. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.

a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:

1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.

c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:

a. Data from entry-control devices; use this input to change modes between access and secure.
b. Database downloads and updates from the server that include enrollment and privilege information.

3. Outputs:

a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.
b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries (Request-to-Exit contacts in door hardware or motion sensor.
c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the server.
d. Door Prop Alarm: If a portal is held open for longer than 20 seconds alarm sounds.

4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.
5. Data Line Problems: For periods of loss of communication with the server, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.
    a. Store up to 1000transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the server on restoration of communication.
6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.
    a. Backup Battery: Premium, valve-regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 19-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.
    b. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.
    c. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to server. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:
        1) Trouble Alarm: Normal power-off load assumed by battery.
        2) Trouble Alarm: Low battery.
        3) Alarm: Power off.

2.7 CARD READERS

A. The UNCW campus uses a multi-tech HID One Card which includes HID iClass technology as well as NXP MIFARE technology. The HID iClass chip in the One Card is used to interact with the campus Lenel Access Control System. The MIFARE chip included in the card is used for UNCW Point of Sale Services.

B. Standard HID Signo readers are capable of reading both technologies included in the UNCW One Card. The use of standard readers will result in failures when cardholders attempt to use their cards at authorized reader locations. For this reason, UNCW requires the use of specific HID Signo readers that are programmed to only recognize HID iClass technology. Each reader will need to be programmed by HID Reader Management application. Please Contact Physical Security and Access to program each reader that is installed with the UNCW Reader Template. Below is a list of authorized HID iClass reader models and part numbers.

1. HID Signo 40 Keypad Reader with terminal connection – Part Number: 40KTKS-00-00000 *this reader is the standard to be used for all installations unless a change has been approved by the UNCW Physical Security and Access Manager.
2. HID Signo 40 Keypad Reader with pigtail connection – Part Number 40KNKS-00-000000
3. HID Signo 40 Reader with terminal connection – Part Number 40TKS-00-000000
4. HID Signo 40 Reader with pigtail connection – Part Number 40NKS-00-000000
5. HID Signo 20 Keypad Mullion Mount Reader with terminal connection – Part Number 20KTKS-00-000000
6. HID Signo 20 Keypad Mullion Mount Reader with pigtail connection – Part Number 20KNKS-00-000000

7. HID Signo 20 Mullion Mount Reader with terminal connection – Part Number 20TKS-00-000000
8. HID Signo 20 Mullion Mount Reader with pigtail connection – Part Number 20NKS-00-000000

2.8 DURESS-ALARM SWITCHES

A. Description: A switch with a shroud over the activating lever that allows an individual to covertly send a duress signal to master control unit, with no visible or audible indication when activated. Switch shall lock in activated position until reset with a key.

1. Minimum Switch Rating: 50,000 operations.
2. Foot Rail: Foot activated, floor mounting.
3. Push Button: Finger activated, suitable for mounting on horizontal or vertical surface.

B. Basis-of-Design Product: Subject to compliance with requirements, provide manufacturer's name; product name or designation

1. General Electric Company; GE Security, Inc.
2. Honeywell International Inc.; Honeywell Security.
3. Visonic Inc.

2.9 PUSH-BUTTON SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Securitron Magnalock Corporation; an ASSA ABLOY Group company.

B. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.

C. Electrical Ratings:

1. Minimum continuous current rating of 10A at 120-V ac or 5A at 240-V ac.
2. Contacts that will make 720 VA at 60A and that will break at 720 VA at 10A.

D. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

E. Enclosures shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors.

F. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.10 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged, and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Division 08 Section "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

E. Vehicle Gate Operator: Interface electrical operation of gate with controls in this Section. Vehicle gate operators shall be connected, monitored, and controlled by the security access controllers. Vehicle gate and accessories are specified in Division 32 Section "Chain Link Fences and Gates."

2.11 REQUEST-TO-EXIT DEVICE (INFRARED)

A. Passive infrared motion detector to sense a person on the secure side of door and provide a dry contact indication to the access control system.

1. Adjustable timed relay output
2. Swivel mount for attachment to wall, ceiling, or door frame
3. Electrical:
   a. Voltage: 12-28V DC or 12.5V AC
   b. Current: Less than 50 MA
   c. Contacts: (1) Double Pole, Double Throw relay, 30A rated.
4. Dimensions: 7"W x 2"H x 2" D
5. Environmental: 32-122 Deg F.

B. Manufacturer: Dortronics Systems, Inc 6612 Series or equivalent.

2.12 DOOR POSITION SWITCH

A. Magnetic door position switches for placement in door jambs and corresponding position in the door to provide indication when door is opened.

2.13 FLOOR-SELECT ELEVATOR CONTROL

A. Elevator access control shall be integral to security access.

1. System shall be capable of providing full elevator security and control through dedicated controllers without relying on the control-station host PC for elevator control decisions.
2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.
3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.
4. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database. Floor-select button shall be enabled only in the car where the credential holder is the passenger.

B. Security access system shall record which call button is pressed, along with credential and time information.

1. System controller shall record elevator access data.
2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.
3. The floor-select elevator control shall allow for manual override from a workstation PC either by individual floor or by cab.

2.14 VIDEO AND CAMERA CONTROL

A. Control station or designated workstation displays live video from a CCTV source.

1. Control Buttons: On the display window, with separate control buttons to represent Left, Right, Up, Down, Zoom In, Zoom Out, Scan, and a minimum of two custom-command auxiliary controls.
2. Provide at least seven icons to represent different types of cameras, with ability to import custom icons. Provide option for display of icons on graphic maps to represent their physical location.
3. Provide the alarm-handling window with a command button that will display the camera associated with the alarm point.

B. Display mouse-selectable icons representing each camera source, to select source to be displayed. For CCTV sources that are connected to a video switcher, control station shall automatically send control commands through a COM port to display the requested camera when the camera icon is selected.

C. Allow cameras with preset positioning to be defined by displaying a different icon for each of the presets. Provide control with Next and Previous buttons to allow operator to cycle quickly through the preset positions.

2.15 CABLES

A. From Telecom Closet to Junction box: A (1) inch conduit is required from the control board out to a junction box in the ceiling above the door to encase all the following wires:

B. Lock Power: Refer to Chart below:

Lock	AWG	Max Distance	Example
EL98/99NL	12	180 Feet	Belden 8477
QEL98/99NL	12	300 Feet	Belden 8477
Mortise/Strike	16	300 Feet	Belden 8471

C. Door Position and Request to Exit Cables:

1. In single door application: A (1) pair 22-gauge stranded cable is used for RX connections. This cable shall be run to the center door hinge area of the door using 3/4-inch flex conduit from the junction box and shall be terminated with an electric pass through hinge. A (1) pair 22-gauge stranded cable for the DPS shall be run in ¾ inch flex conduit from the junction box to top of door frame, no farther than one foot from latch side of door.
2. In double door application: The right-hand door from the outside or reader side shall require all specifications of single door wiring. The additional door shall require (1) pair 22-gauge stranded cable for the DPS and shall be run in 3/4-inch flex conduit from the junction box to top of door frame, no farther than one foot from latch side of door, and a second (1) pair 22-gauge stranded cable will be required for RX connections in a 3/4-inch flex conduit from the junction box to the center hinge of the door.

D. Card Reader Wire:

1. Pulled to single gang box at the card reader location: A (3) pair 22-gauge shielded stranded gauge wire shall be used for the door reader and pulled through a 3/4-inch flex conduit from the junction box to a single gang junction box in the area designated for mounting of the card reader.
2. Handicap Door Controller Cable: Pulled to Handicap Door Controller: If a handicap door opener is required, a Cat 6 cable or 22/6 stranded shielded wire shall be pulled from the access control board to the control board of the handicap opener. This shall pass through the junction box and be in a 3/4-inch flex conduit to the handicap door opener control board. All terminations of this wire shall be performed by the installation contractor. Termination and installation of opener and paddles is the responsibility of the GC.

PART 3 - EXECUTION

3.1 SYSTEM SUPPLIER AND/OR SUBCONTRACTOR REQUIREMENTS

A. Provide and/or supervise all wiring, wire terminations and connections.

B. Provide and/or supervise all equipment installation.

C. Perform and/or supervise all testing during and after installation.

D. Certify in writing to the Architect (copy to Engineer) at completion stating that system has been inspected, tested and is complete and fully operational in accordance with contract documents.

3.2 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Comply with TIA/EIA 606-A, "Administration Standard for Commercial Telecommunications Infrastructure."

B. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. For each Location, record setup of controller features and access requirements.
2. Propose start and stop times for time zones and holidays, and match up access levels for doors.
3. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
4. Assign action message names and compose messages.
5. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
6. Prepare and install alarm graphic maps.

7. Complete system diagnostics and operation verification.
8. Prepare a specific plan for system testing, startup, and demonstration.
9. Develop acceptance test concept and, on approval, develop specifics of the test.
10. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format

C. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.4 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

F. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.5 CABLE APPLICATION

A. Comply with TIA 569-C, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 485-A Cabling: Install at a maximum distance of 4000 ft.

D. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 20 AWG wire if maximum distance is 500 ft.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft.

F. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft.

3.6 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.7 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. Install card readers, keypads, push buttons, and biometric readers.

3.8 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA 606-A.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

3.9 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner. Provide all passwords to Owner.

3.10 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. Tests and Inspections:

1. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
2. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 STARTUP SERVICE

A. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

B. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.12 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.13 DEMONSTRATION

A. Security Personnel Instruction. Provide a minimum of 4 hours training program for security personnel. Total time shall be scheduled in sessions to be coordinated with building management. Training program shall be conducted by a qualified installation engineer, fully familiar with the entire system as it pertains to this project. The sessions shall be clarified by the use of operating manuals.

B. Develop separate training modules for the following:

1. Security personnel.
2. Corporate management.

3.14 OPERATION AND MAINTENANCE MANUALS

A. Operating Manuals. Provide in accordance with Section 280500 - Common Work Results For Electronic Safety and Security. Manuals shall contain a preventive maintenance program and service instructions for components of the system as a whole and each component, function and operation in detail. Manuals shall be written to aid in training of new security and operating personnel and as guide clarifying operational procedures.

B. Maintenance Manuals. Provide in accordance with Section 280500 - Common Work Results For Electronic Safety and Security. Manuals shall contain a preventive maintenance program and service instruction for all components of the system. Manuals shall include illustrations, mounting instructions, wiring diagrams, parts lists, operating instructions and a trouble-shooting chart for the system, including a list of troubles, causes and recommended remedies. Include wiring diagram showing all components.

C. Spare Parts List. Submit list of spare parts and components of critical items for consideration of purchase by Owner.

3.15 MAINTENANCE AND SERVICE

A. General Requirements: Provide all services, materials, and equipment necessary for the successful operation of the entire system for a period of one year after completion of the operational acceptance test. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and nonscheduled work.

B. Description of Work: The adjustment and repair of system includes all computer equipment, software updates, transmission equipment, card readers, and all control devices. Provide the manufacturer's required adjustments and all other work necessary.

C. Emergency Service: The Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system. Furnish the Owner with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. Restore the control system to proper operating condition within 3 days.

END OF SECTION 281300

SECTION 282300 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section includes product and execution requirements for Video Surveillance Systems. Unless noted otherwise, work under this section is subject to requirements of Section 28 0000.

B. The purpose of this document is to define the standards and procedures for the installation of security cameras, security camera systems and all ancillary equipment on the campus of the University of North Carolina at Wilmington (UNCW) and all properties owned or leased by the university. The integrity of all equipment, cabling and proper installation is essential to the University's commitment to providing a safe and secure environment for students, faculty, staff and visitors of UNCW. These standards and procedures will be re-viewed and updated regularly to ensure that are up-to-date and accurate.

C. All standards and procedures in this document shall be compliant with all relevant laws or directives set forth by the Federal Government, the State of North Carolina, The University of North Carolina System and the University of North Carolina at Wilmington. In addition, all contractors installing security camera equipment on property owned or leased by the University of North Carolina at Wilmington shall be fully licensed in the State of North Carolina pursuant to N.C.G.S. 74D, the Alarms Systems Licensing Act.

1.2 SYSTEM DESCRIPTION

A. Refer to Section 280000 for additional information and requirements.

B. Complete, turnkey Video Surveillance System compliant with applicable codes and standards referenced herein and as indicated on drawings. Section includes:

1. Structured cabling
2. IP Cameras
3. Server
4. Storage
5. Programming
6. Testing
7. Integration

C. The video surveillance system shall provide visual surveillance of the areas noted. The cameras shall be types as indicated on drawings and schedules.

D. Cameras shall capture events at

1. Pedestrian entry and exit doors
2. Entry into UT staff spaces
3. Locations to support Emergency Systems
4. Locations to support access control systems
5. Lobbies
6. Parking/Vehicle Entrances
7. Surface Parking Lots
8. Secured areas

E. UNCW shall provide, install and maintain the system video servers. The specifications for the server shall be provided by the UNCW Physical Security and Access.

F. UNCW shall provide all network equipment to include network switches.

G. The UNCW Network Data Analyst shall assign switches, ports and IP addresses for use in new camera installations.

H. The UNCW Physical Security and Access Manager, shall provide user-names, passwords and IP addresses to the contractor.

I. UNCW Physical Security and Access and a UNCW Police Department representative shall approve the final aiming and focus.

J. The UNCW Network Infrastructure Analyst shall monitor the installation to ensure that all UNCW NetCom Department standards are satisfied.

K. Upon completion of the installation a final meeting may take place to include the UNCW Department that requested security cameras, UNCW Physical Security and Access, the UNCW Project Manager in charge of the project, the UNCW Network Infrastructure Analyst and the UNCW Network Data Analyst.

L. This group shall review the installation to be sure all requirements and standards have been met before the contractor has been released from the job.

M. The contractor shall ensure that they are operating in compliance with North Carolina General Statute 74D. (Alarms Systems Licensing Act)

N. The contractor shall provide and install all cameras, ancillary equipment or parts required for a complete installation as specified by UNCW standards.

O. Any substitutions must be submitted to the UNCW Physical Security and Access Manager for approval.

P. The contractor shall provide and pull all data cabling and ground wire as re-quired.

Q. The contractor shall ensure that the latest firmware approved for use with LENEL video software is installed in all cameras. Contact the UNCW Physical Security and Access Manager for firmware version.

R. The contractor shall program cameras with the IP address, user name and password provided by the UNCW Physical Security and Access Manager.

S. The contractor shall label all cables and wires. Camera labeling shall conform to the UNCW Physical Security and Access standard. Contact the Physical Security and Access Manager for more information.

T. The contractor shall schedule a time with the Physical Security and Access Manager and a UNCW Police Department representative to approve the final aiming and focus of all installed cameras.

U. All cameras shall be compatible with the current software version of Lenel OnGuard Access Control and Security System in use at UNCW.

V. Camera security systems shall include a system of Surge Suppression that conforms to the standards set forth in this document.

W. Cabling and cabling installation shall meet or exceed all specifications as per the Standards for Installation of Infrastructure and Telecommunication Equipment provided by UNCW NetCom Department. The UNCW Network Infrastructure Analyst shall be the point of contact for all issues that pertain to the cables, patch panels and other telecommunications equipment.

X. Camera systems shall conform to the approved equipment list and application schematics provided in this document.

Y. The contractor shall provide "As Built" drawings to UNCW Physical Security and Access.

1.3 RELATED WORK

A. Responsibility for integrating electronic and electrical systems and equipment is specified in the following Section:

1. Refer to Section 280000 for additional information and requirements.

B. Related Division 26 Sections include:

1. Section 260529 - Hangers and Supports for Electrical Systems
2. Section 260533 - Raceway and Boxes for Electrical Systems
3. Section 260593 - Electrical Systems Firestopping

C. Related Division 27 Sections include:

1. Section 270553 - Communications Systems Identification
2. Section 271000 - Structured Cabling
3. Section 271100 - Communications Equipment Room Fittings
4. Section 271500 - Communications Horizontal Cabling

D. Related Division 28 Sections include:

1. Section 280000 - General Electronic Safety and Security Requirements
2. Section 280513 - Conductors and Cables for Electronic Security
3. Section 281300 - Access Control

1.4 REFERENCES AND STANDARDS

A. Refer to Section 280000 for additional information and requirements.

B. Refer to UNCW Security Standards for further information.

1.5 SUBMITTALS

A. Shop Drawings: Prepare block diagrams indicating the proposed connections of all equipment to be furnished, control facilities, and equipment racks. Indicate materials, construction, layouts and quantities

B. Operations and Maintenance Manuals.

1. Furnish simplified as-built block diagrams of the system giving the essentials of the installation and their functional relations with all numbered inputs, outputs and wires printed on the diagrams.

1.6 QUALITY ASSURANCE

A. All equipment shall be furnished and installed by a contractor authorized as a factory certified integrator with proven experience in the design and installation of systems of this type. Contractor shall provide proof of being in the video surveillance contracting business for the preceding five (5) years.

B. Construct the system following good engineering practices and in accordance with applicable codes and safety precautions.

C. Periodically inspect portions of the system installed by other contractors to minimize potential interference problems.

D. All materials and equipment shall be new and shall conform to the applicable requirements of the Underwriter's Laboratories and with the American National Standards Institute.

1.7 WARRANTY

A. All equipment shall be guaranteed to be free of defective components or faulty workmanship for a period of one year from the date of final acceptance. If any materials prove to be defective within the above period, they shall be replaced within 24 hours at no expense to the owner. In the case of a service call during the warranty period a representative will contact the owner within 30 minutes by phone and be on site if required by the owner within 4 hours at no cost to the owner.

PART 2 - PRODUCTS

2.1 VIDEO SURVEILLANCE SYSTEM

A. Manufacturer:

1. Axis
2. Approved Owner alternate shall be product by Lenel (OnGuard).

B. Elevator cabs shall be continually monitored 24/7 by campus police.

C. Internal and External cameras shall be vandal resistant.

D. External cameras shall be built to withstand the extreme temperature and coastal weather conditions of southeastern North Carolina.

E. Cameras shall include day and night functionality.

F. Cameras shall have a minimum 2.0 MP resolution.

G. Cameras shall be minimum H.264 compatible.

H. All cameras shall be compatible with the latest versions of Lenel OnGuard in use by UNCW.

I. Cameras shall conform to the list of approved make, types and models provided by UNCW Physical Security and Access. Contractors shall be provided the approved list upon request.

J. The Contractor shall provide a digital, TCP/IP based VMS system, which shall include any and all equipment/peripherals, licenses as required to facilitate the functionality and operation desired.

1. Requirements

a. Camera housing colors shall match the surface to which they are being affixed. The Contractor shall coordinate the exact pantone color with the Architect, prior to ordering any surveillance equipment.
b. The NVR shall be ONVIF compliant and seamlessly integrate through an Application Program Interface (API), Software Development Kit (SDK) to the ACMS.
c. Cameras shall be powered by an Owner provided network switch utilizing the network cable. Power injectors (midspans) shall be provided by the contractor when required for proper operation.

d. Grounding as required per manufacturer's recommendations.
e. NVR/Camera devices that require annuity licensing/costs shall not be acceptable and total annuity costs incurred will be the burden of the Contractor.

2. System Security

a. VMS systems shall be equipped with methods/protocols to preclude unauthorized remote access.

1) All peripherals shall have unique passwords, which shall include alpha numeric combinations with uppercase, lowercase and symbols. Passwords shall not be less than eight characters and shall independent of each camera.
2) The Contractor shall coordinate and advise the Owner on other additional precautions that could be utilized to preclude unauthorized access to TCP/IP cameras. Some precautions include, but are not limited to the provisioning of: Virtual Private Networking (VPN), Subnet protocol, port filtering, static IP addressing, MAC filtering, SSL/TLS and of network intrusion detection systems/software, HTTPS encryption, IEEE 802.1Xa, network access control, digest authentication, user, access log, centralized certificate management or proxy servers.

b. Lens Optics

1) Lens focal lengths shall be coordinated with the Owner based on the field of views required by the Owner. Selected optics shall be designed for the transmission of digital/analog images and shall be coated, color corrected/Infra-red corrected, aspherical with low dispersion.

a) Lenses shall be either C or CS type and shall be varifocal with an automatic iris.

K. Workstation

1. The Owner shall provide workstations as indicated on the drawings.
2. Contractor shall be responsible for installing client software on workstation for Electronic Access Control and Video Management.

L. Megapixel Cameras

1. General

a. Unless superseded herein, all cameras shall have a minimum digital resolution capability of 2 megapixels minimum for individual non-stitched video fields of view.
b. Provide coordinated fields of view and usable images where people, objects, colors that are within the cameras field of view are readably discernible.
c. The Contractor shall provide the earliest model number/version for the cameras identified herein and as annotated on the drawings.
d. Cameras shall be fully compatible with the NVR system being specified. Cameras without manufactured approved Software Development Kits (SDK) and proven, verified Application Program Interfaces (APIs) or that are not ONVIF compliant shall not be allowed.
e. Cameras provided shall be rated for the environments where they shall be installed.
f. Housing shall incorporate thermostatically controlled heating element and air circulation as rated by the manufacturer for continuous operation in ambient temperatures of minus 30 to plus 120 degrees F dry bulb and up to 85 percent relative humidity.
g. The camera mounting shall be sufficient to prevent the mount from being pried from the mounting surface.
h. Power Over Ethernet (POE) integrated RJ-45 10-base TX (10/100) auto sensing network interface, with the following certifications: IEEE 802.3af, IPv4 (RFC 791), IPv6 (RFC 2460), QoS – DiffServ (RFC 2475)

i. The Contractor shall coordinate network requirements inclusive of IP addresses, network environment that shall be confirmed by the Owner, prior to final connection to the network.
j. Cameras shall utilize dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server and in accordance to the Owner's network environment.
k. As required, the Contractor shall provide a backlight compensating cameras to support useable video in instances of a bright foreground, and dark background

2. Cameras shall:

a. Support multi-cast streams in a variety of bandwidths and resolutions simultaneously.
b. Vandal resistant for indoor cameras.
c. Camera shall support the following protocols: TCP/IP, UDP/IP, FTP, SMTP, HTTP, DHCP, DNS, DDNS, NTP, SNMP, unicast, multicast
d. Edge storage

1) Camera shall support continuous and event-controlled recording to: local Solid-State Density (SSD) memory via a SD-card

e. Tamper screws (pin-in-hex or pin-in-torx button head screws).
f. shall be provided on all camera and a tool shall be provide to the Owner to service the cameras
g. Cameras shall be installed in accordance to the environments they are being installed. In addition to inclement weather, the Contractor shall securely fasten/mount cameras to the surface they are being mounted to.
h. Cameras shall be manufactured by Axis or approved equal.
i. Cameras shall be powered via Power Over Ethernet (POE). POE network switches shall be provided by the Owner.

3. Mounts

a. Camera mounts shall be provided as required. Mounts shall be properly fasted to the surface they are being affixed. Conduit within finished spaces of the building, service corridors, and docks shall be concealed. All mounting shall be pursuant to manufacturer requirements.
b. Mounting

1) Interior: Interior mounting within finished spaces shall be low-profile and recessed into the wall or ceiling. When mounting in the ceiling, safety chains/cable shall be provided and attached to a building structure.
2) Exterior: Unfinished spaces shall be surface mounted, and conduit shall be painted to match the material the camera is being affixed to.
3) Light/stanchion mounting: As identified on the security drawings, integrate camera mounting with stanchion coordinate Effective Projected Area (EPA) with stanchions being provided. Refer to details for additional information.

c. Camera mounts shall be fully supported and compatible with camera system and shall be manufactured by Axis.
d. Approved Owner alternate shall be Anixter.

M. Outdoor Fixed Dome Style Megapixel Cameras:

1. The camera shall be a vandal resistant, high security dome style camera.
2. All cameras, in this category, shall be equipped with a 2.5 – 6mm or a 3.3 –
3. 12mm variable focus lens as needed for the desired field of view.
4. Camera shall be AXIS Model P3343-VE or approved equal.
5. Approved Owner alternate shall be product by Lenel (OnGuard).

N. Indoor Fixed Dome Style Megapixel Cameras:

1. The camera shall be a vandal resistant, high security dome style camera.
2. All cameras, in this category, shall be equipped with variable focal (3 – 9mm) lenses.

3. It shall be the Security Contractor's responsibility to ensure that the latest version of firmware, that is compatible with the Video Management System, is down-loaded to all cameras prior to Final Inspection.
4. Camera shall be AXIS Model P3343-V or approved equal.
5. Approved Owner alternate shall be product by Lenel (OnGuard).

O. Elevator megapixel cameras:

1. Elevator Cab Cameras require a special CAT 6 cable. Commscope Part # 874049304/10 or approved equal.
2. The CAT 6 cable is attached to the cab travel cable and terminates with a RJ45 connector in the elevator control panel in the elevator equipment room. A grounded Ditek MRJPOE is used to connect this cable to a standard CAT 6 cable that is pulled to the Security Room Camera Rack. The opposite end is terminated with a RJ45 jack above the camera location in the elevator cab. See drawings for an illustration of a typical Elevator Cab Camera installation.
3. A "Variance Request Letter" is required to be drafted by the contractor and sent to NCDOI Elevator and Amusement Device Bureau for approval. A
4. Elevator Cab Cameras shall conform to a list of approved make, types and models provided by UNCW Physical Security

P. Network Specifications (All Cameras):

1. Network: 100BASE-TX
2. Cabling: CAT6
3. Connector: RJ-45
4. Security: SSL
5. Protocols: UDP, TCP, SOAP, DHCP, Zeroconf

Q. Electrical Specifications (All Cameras):

1. Power Source: PoE: IEEE 802.3af Class 3 compliant, 24 VAC, 12-24 VDC
2. Power Consumption: 6 W

R. + 5.5 W with heater (if required)

1. + 3.5 W with IR illuminator (if required)
2. Power Connector: 2 pin terminal strip

S. All cameras shall include a 1 year warranty.

T. Acceptable camera manufacturers shall include Axis, or approved equal.

1. Approved Owner alternate shall be product by Lenel (OnGuard).

U. Camera Lenses

1. A. Camera lenses shall be compatible with the camera construction and iris control circuit. The lenses shall be compatible with remote control devices as specified herein. The lenses shall be supplied by the same camera manufacturer.
2. All lenses shall be auto iris type driven by the camera iris control circuit. Additionally, all exte-rior lenses shall be equipped with spot filters giving the lens a minimum effective aperture of f/360.
3. Lens size shall be as indicated on the drawings and/or camera schedule.
4. Acceptable manufacturers shall include Axis, or approved equal.
5. Approved Owner alternate shall be product by Lenel (OnGuard).

V. Camera Housings and Supports

1. All camera housings and support brackets shall be compatible with camera specified herein.

2. Housings shall be provided with cable entrance facilities for camera control and power and shall be adaptable to mounting devices used with cameras. All mounts shall be "Feed Through" type to ensure that power, signal, and data cables are concealed. All camera housings and support brackets shall be securely attached to mounting surfaces. Escutcheon plates attached with security screws shall be used to conceal holes in walls or ceilings. Manufacturer guidelines for mounting devices and support brackets shall be adhered with unless contract details exceed
3. manufacturer guidelines.
4. The camera housings or unitized camera housing assemblies must incorporate the following as a minimum:
    a. Mounting hardware with security screws that allow access into the camera housings or units with only special tools
    b. Impact resistant domes or viewing ports.
    c. Cable routing for power and video signal routed through the mount or back of the camera so that no cable is exposed after the installation.
5. Exterior Housing: Housings shall be medium-sized "Dome" environmental housings designed for wall mount applications. Domes shall be rated as vandal proof, impact resistant type.
6. All exterior housings shall be provided with tamper resistant kit, and mounting hardware.
7. Reference manufacturer guidelines for mounting requirements.
8. Interior Domes: All mini-dome style cameras, installed in lay-in tile ceilings, shall be supported by T-bar Support Kits.
9. Reference camera details and/or schedule for housing and mount types required.
10. Acceptable manufacturers shall include Axis or approved equal.
11. Approved Owner alternate shall be product by Lenel (OnGuard).

W. Data Surge Protector

1. Provide Cat 6 Surge Protector in an enclosure located within 6 feet of each camera. See drawings for more info.
2. Provide hinged enclosure located within 6 feet of each camera to house surge protector and Ground bar
3. Provide Ground Bar in enclosure to provide a connection to ground for camera surge protectors.
4. The distance between the Ditek MRJPOE modules and ground should be less than the cable distance between the module and the camera it protects.
5. Provide #6 AWG, Green, Insulated, and Stranded Ground Conductor from TMGB in Main Telecom Room to Ground Bar. Provide #12 AWG, Green, Insulated, and Stranded Ground Conductor from ground Bar to each camera Surge Protector
6. Ditek Part # DTK-MRJPOE

X. Rack Mount Data Surge Protector

1. Provide rack mounted12 port Surge Protecton Patch Panel. Surge Protecton
   Patch Panel shall be grounded using #8 AWG wire to TMGB or Security Room Grounding Block
2. Ditek Part # DTK-RM12POE

Y. RJ-45 Jacks

1. Biscuit style data outlets shall be provided for network connectivity at the camera location
2. Outlets shall be mounted in enclosures as illustrated on the project drawings.
3. Outlets shall be manufactured by the solution selected for the structured cabling system in Section 271000.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Interface the video surveillance system with the Access Control System. Activation of the associated door switch alarm or duress alarm shall automatically place the cameras on the General Video Spot Monitor at the Security Monitoring Workstation Cluster that acknowledges the alarm.

B. Provide video monitors at the Video Monitoring Areas identified on the drawings. Coordinate with the owner for locations and sizes.

C. All cameras cables will be supported with CAT6 cable. The cable will be provided, installed and tested by the Division 27 contractor.

D. Cable color shall be YELLOW.

E. It shall be the responsibility of the contractor to cooperate with representatives of the owner in order to achieve well-coordinated progress and satisfactory results. Schedule all work to prevent conflicts with other activities in the building.

3.2 CAMERA PLACEMENT

A. Camera placement shown on drawings is approximate. Contractor shall place all cameras to provide maximum coverage of intended viewing area. Review proposed camera installation locations with Owner prior to installation.

B. Coordinate placement of cameras in ceilings with the work of other trades.

C. Position cameras to avoid viewing direct light sources.

3.3 TESTING - GENERAL

A. On completion of the system installation, demonstrate that proper video and quality have been maintained through all signal paths. All test equipment shall be provided and calibrated by the video surveillance contractor.

B. Signals must comply with the manufacturer’s specification for each piece of equipment under test. If discrepancies between the test results and the manufacturer’s specifications are noted, this shall be brought to the attention of the consultant and appropriate corrective action taken.

C. All adjustments to equipment shall be made by a qualified technician.

D. Notify the Owner a minimum of 48 hours prior to testing so that he may, at his discretion, furnish representatives to witness the testing procedure and results.

E. Submit copies of the test results as described above prior to final acceptance and training. Include copies of the test results. Include the names of the individuals performing and witnessing the tests, and the manufacturer’s name and model number of the test equipment used. Include a block diagram of the test setup for each test.

F. Cameras shall be setup and adjusted to accommodate the different lighting conditions present in the room.

G. Securely mount all camera housings and brackets to support structure using approved fastening methods. Mounting shall adequately support camera, housing, and all accessories. Contractor shall consider the effects of wind, snow, and ice loading when mounting exterior cameras. All exterior fasteners shall be rust-proof. Seal all exterior building penetrations in an approved manner to make water-tight.

H. After installation, field adjust cameras and internal camera settings in accordance with manufacturer's instructions. Cameras shall be adjusted to provide the best possible performance under installed conditions.

I. During construction phase, protect cameras and housings from dust, paint, moisture, and the like. Provide temporary protective masking as needed. Upon completion of construction, and prior to final Acceptance test, remove protective masking and thoroughly clean all cameras and housings.

J. On completion of testing, every camera shall have a 30 second video recorded and stored on one of the hard drives as well as on a USB thumb drive. This set of recordings will establish the quality of the cameras at installation and document the correct camera labeling as well as the date and time of the recordings. These recordings may be used in the future to review system degradation.

3.4 FIELD ADJUSTMENTS

A. Contractor shall make final field adjustments to cameras as requested by Architect or Owner's Representative at time of Demonstration at no additional cost to the owner.

B. Final field adjustments may include, but shall not be limited to:

1. Relocation of camera housing within ceiling grid spaces.
2. Change of camera positioning within housing.
3. Change of lens settings to provide improved coverage.
4. Adjustment of focus, iris and internal camera settings.

END OF SECTION 282300

SECTION 283116 - MULTIPLEXED FIRE DETECTION AND ALARM 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 RELATED WORK

A. Section 142400 - Hydraulic Elevators

B. Section 211314 - Automatic Fire Sprinkler System

C. Section 211318 - Fire Protection Systems

D. Section 230993 - Control Sequences

E. Section 260000 - General Electrical Requirements

F. Section 260519 - Low-Voltage Electrical Power Conductors and Cables

G. Section 260526 - Grounding and Bonding for Electrical Systems

H. Section 260533 - Raceway and Boxes for Electrical Systems

I. Section 260553 - Electrical Systems Identification

1.3 REFERENCE

A. The Work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. This specification is written to incorporate all applicable requirements of NC Department of Insurance and State Construction.

C. All criteria for Fire Detection and Alarm Systems as outlined by the State of North Carolina has been met or exceeded by requirements of this specification.

1.4 DESCRIPTION

A. Fire alarm system design and construction will be coordinated through the University's Project Manager who will in turn coordinate with the UNCW Office of Safety, UNCW Telephone Services, and end users.

B. Contact ID transmission format used to transmit signals to the University Police Station.

C. The communicator shall be dual cellular model SLE-LTEVI-FIRE by Napco Starlink. The communicator shall be provided by the contractor. Sentinel Security shall setup and program the unit, coordinate with UNCW & Sentinel Security in Wilmington, NC.

D. The designer will perform a 100% test on all fire alarm devices during the prefinal inspection, and a representative from the UNCW Office of Safety will accompany the designer during this test. Additionally, other UNCW representatives may also be present at this test, including the Project Manager and a representative from UNCW Facilities Operations. A sensitivity report shall be submitted to the designer three days prior to the inspection, and no device shall be more than 2% dirty.

E. Provide the following:

1. User defined control switches (or buttons) shall be located on the user interface of the FACP. Separate switches are not allowed. Separate switches shall be provided for HVAC bypass, elevator bypass, fire door bypass, and city disconnects. These switches shall report a supervisory signal to the FACP upon activation.
2. A/V bypass shall be by password protected software function with a maximum of 10 points to disable to achieve bypass.
3. SNAC panels shall have built in synchronization for strobes. No external devices shall be used.
4. Two sets of glass-framed floor plans indicating all fire alarm devices and device numbers shall be provided. One plan shall be mounted adjacent to the FACP and the other shall be mounted beside the remote annunciator. These plans shall be secured to the wall with screws.
5. Two separate days of training will be provided, divided over two days.
6. The site-specific program for the fire alarm system shall be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A CD copy shall be submitted to the engineer for transmission to the owner.
7. Provide a speaker silence function with no delay.
8. Delay shall prevent the silence function from engaging. This silence function shall be manually activated and shall not prevent visual devices from flashing.

F. Provide adjacent to the fire alarm control panel:

1. Telecommunications outlet consisting of 2 voice and 1 data port shall be installed adjacent to the fire alarm control panel.
2. 12”x12”x4” deep box with a hinged cover, with a 120 volt receptacle inside.
3. Printer stand with paper storage.

G. Provide a complete local, electrically operated, electronically supervised, addressable fire alarm system including all necessary equipment, materials and wiring. System shall be microcomputer based, utilizing distributed processing techniques, operating at a nominal 24VDC. System shall include, but not be limited to: central control unit, display unit, annunciator panel, manual and/or automatic signal initiation devices, alarm signal devices, conduit, wire, fittings, accessories, and all other necessary materials for a complete operating system as per the specs and drawings.

1. System shall operate as low-voltage, general evacuation fire alarm system. The system, in no circumstances, shall be utilized as a general building paging system. It shall have one-way voice communications.
2. Transmit signals to the University Police Station. The communicator shall be dual cellular unit.
3. System shall be listed for releasing service. System will be used to detect fire conditions and provide appropriate signals to release fire suppression systems. Provide all hardware, wiring, accessories and coordination to interface detection and control components with releasing valves specified in Division 21.

H. Components of the system, including assemblies such as control panels and annunciators, shall be listed specifically for its intended use. System shall operate as low-voltage, general evacuation fire alarm system. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated. If that listing isn’t available, provide third party NRTL listing agency shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment”.

I. System shall:

1. Be an intelligent analog system.
2. Allow for loading and editing special instructions and operating sequences as required.
3. Be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
4. Be wired, connected, and left in operating condition.
5. Use addressable relay modules and monitor modules to interface with building automation system (BAS) for closing of smoke dampers upon reduction of air flow in duct work to velocities below detection level of duct detectors when fans are reduced in power or shut down.
6. Use addressable relay modules and monitor modules to interface with building automation system (BAS) for providing output to BAS from fire alarm system based on smoke detection or waterflow by zone and status monitoring by fire alarm system from BAS for monitoring of supply and return fan run status operation and air handler smoke control mode status.
7. Use addressable input monitor modules to interface with emergency generator and automatic transfer switches for status monitoring.
8. Use addressable input monitor modules to interface with fire pump(s) controller(s) for status monitoring.
9. Use addressable output relay modules and addressable input monitor modules to interface with sprinkler system waterflow switches, valve supervisory switches, pressure switches, pre-action system control panels, aspirating smoke detection control panels, waterflow alarm indication devices.
10. Use addressable output relay modules and addressable input monitor modules to interface with building security system door hardware devices at control panels and individual doors for control and releasing by fire alarm system.
11. Use addressable output relay modules and addressable input monitor modules to interface with elevator equipment control panels for elevator recall functions.
12. Interface with elevator equipment control panels for one-way voice communication system.
13. Use addressable input monitor modules to interface with fire pump monitoring.

J. Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.

K. Unless notes, otherwise all initiation device circuits shall be wired Class A; notification appliance circuits shall be wired Class B and signaling Line Circuits shall be fully complying Class A, Style 6 with no “T” taps.

L. System shall be installed in accordance with and shall meet or exceed applicable codes, including: NFPA 72, NEC 760, UL Standard "Control Units for Fire Protection Signaling Systems;" and the NC State Electrical Code.

M. The complete fire alarm system shall meet UL certification as installed.

N. All work will be subject to State Construction Office inspection and approval and must comply with NEC and NFPA specifications and guidelines.

O. The Contractor shall furnish all parts, materials, and labor required for a complete and operating system in accordance with all applicable requirements, even if each needed item is not specifically shown or described in the project plans or specs.

P. The AHJ for NEC Code compliance is the State Construction Office. The Engineer will manage the fire alarm system inspection or acceptance testing.

Q. The installed fire alarm system shall be fully serviceable and programmable by the University’s personnel.

1.5 REFERENCE STANDARDS

A. NCBC - 2018 – North Carolina Building Code

B. IFC - 2018 – North Carolina Fire Code

C. NECA 305 - Standard for Fire Alarm System Job Practices

D. NFPA 72 - National Fire Alarm and Signaling Code

E. NFPA 101 - Life Safety Code

F. UL 268 - Smoke Detectors for Fire Protective Signaling Systems

G. UL 497B - Protectors for Communications and Fire Alarm Circuits

H. UL 521 - Heat Detectors for Fire Protective Signaling Systems

I. UL 864 - Control Units for Fire Protective Signaling Systems

J. UL 1481 - Power Supplies for Fire Protective Signaling Systems

1.6 QUALIFICATIONS

A. Equipment shall be supplied by company specializing in fire alarm and smoke detection systems with 5 years documented experience

B. Work shall be performed by licensed contractor regularly engaged in installation and servicing of fire alarm systems.

C. Proof of 5 years documented experience and factory authorization to furnish and install equipment proposed shall be furnished.

D. Contractor shall be located within 100 miles or less from site of project.

1.7 SUBMITTALS

A. Bill of materials listing part number and quantity of components and devices.

B. Block diagrams showing layout and operation of entire system.

C. Plan drawings and riser diagrams showing layout and operation of entire system. Identify all symbols used.

1. Plan drawings are to include all equipment with proposed device numbers, planned wiring paths, etc.
2. Drawings are to indicate design ambient sound level, audible alarm device sound power and alarm sound level for each space.

D. Schematic diagrams, of circuits from field devices to terminal strip(s) associated with control panel.

1. Diagrams shall show schematic wiring of equipment; and connections to be made to devices. Physical sizes of enclosures housing power supplies, consolidated wiring, etc.
2. Terminal connections in equipment shall be numbered to correspond to diagrams.

3. Wiring diagrams shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are same on drawings.

E. Calculations

1. Standby battery power calculations.
2. Strobe power supply calculations showing current draws for every device and module during standby, alarm and trouble conditions.
3. Voltage drop calculations for both initiating and alarming circuits.
4. Audio amplifier sizing calculations showing current draw for every device at proposed audio tap settings.

F. List of device addresses with location labeling as they will appear in 2 line, 40 character display of fire alarm panel and remote annunciator.

G. Product Data:

1. Provide bill of materials (BOM) listing part number and quantity of components and devices in a logical order of interrelated components.
2. Cut sheets of all equipment and devices included in the order listed in the BOM.
3. Circle, highlight, flag or otherwise identify part numbers of specific equipment used. Images, details, or other blocks of information not applicable to the submitted system are to be struck out or otherwise excluded.

H. Operation and Maintenance Manuals shall include the following:

1. As-built wiring diagram showing all loop numbers and device addresses in the system, plus equipment terminal numbers.
2. Manufacturer's detailed maintenance requirements
3. Technical literature on all control equipment, isolation modules, power supplies, alarm/supervisory signal initiating devices, alarm notification appliances, relays, etc.
4. Manufacturer's Installation manual, Operator/User Manual, Programming Manual and Technical Manual
5. The as-built battery sizing calculations

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide Notifier 3030, Simplex 4010 ES or Siemens Sinteso FC2080 fire alarm control system

B. Provide Notifier 3030 fire alarm control system with System Sensor notification devices and FMM-1 monitor modules as a preferred brand alternate per preferred brand alternate specification.

2.2 SYSTEM OPERATIONS

A. Alarm Initiation

1. System alarm operation after activation of any manual station, automatic detection device, or sprinkler flow switch shall be:

a. Appropriate initiating device circuit red LED shall flash on Control Panel and remote annunciator until the alarm has been acknowledged at Control Panel or remote annunciator.
b. Once acknowledged, this same LED shall latch on.

c. Subsequent alarm received after acknowledging shall flash subsequent zone alarm LED on Control Panel and remote annunciator.
d. Acknowledgment of alarm shall not reset activated device.
e. Pulsing alarm tone shall occur within Control Panel and remote annunciator until event has been acknowledged.
f. Alarm audible-indicating devices shall sound in three pulse temporal pattern until silenced by alarm silence switch at Control Panel or remote annunciator.
g. Visual alarm indicating devices shall operate in continuous flashing pattern until system is reset.
h. Signal to notify the local campus police.
i. Doors held open by door control devices shall close.
j. Mechanical controls shall interface with air handling systems as specified by Division 23.
k. Electric water gong when fire pump is running.

2. System shall have single key to allow operator to display alarms, troubles, and supervisory service conditions including time and date of each occurrence.
3. Alarm shall be displayed on an 80-character LCD display as follows:

a. 40 characters for:

1) Point address and loop number
2) Type of device
3) Point status

b. 40 characters for:

1) Custom location label

B. Silencing

1. Alarm audible indicating devices shall be silenced by operating alarm silence switch or by use of key operated switch at remote annunciator.
2. Strobes shall remain active until system is reset.
3. Subsequent zone alarm shall reactivate alarm signals.

C. Reset

1. SYSTEM RESET button shall return system to its normal state after an alarm condition has been remedied.

D. Supervision

1. System shall independently supervise:

a. Initiating device circuits.
b. Duct Smoke detectors shall register as an alarm and close dampers or shut down AHU as required.
c. Fire Pump running, loss of phase, alternate power source, derangement.
d. Hot box low temperature
e. Sprinkler flow and tamper switches.
f. Independently fused indicating appliance circuits for alarm speaker/strobe units.
g. Auxiliary manual controls. "Off normal" position of any switch shall cause an "off normal" system trouble.
h. Auxiliary circuits for addressable relays. Blown fuse or open in circuit shall be visibly and audibly annunciated.
i. Remote annunciator panel. Any ground, short, or open in the wiring to fire alarm Control Panel, as well as malfunction of the annunciator panel shall be annunciated at control panel.

j. Incoming power. Power failure shall be audibly and visually indicated at Control Panel and remote annunciator. Green "power on" LED shall be displayed continuously while incoming power is present.
k. System Modules for module placement. Should modules become disconnected, system trouble indicator shall illuminate, and audible trouble signal shall sound.
l. System batteries. Low battery condition or disconnection of battery shall be audibly and visually indicated at Control Panel and remote annunciator.

2. Device activation shall be annunciated at Control Panel and remote annunciator.
3. Independently supervised circuits shall include visible amber "Trouble" LED to indicate disarrangement conditions per circuit.
4. Disarrangement conditions of any circuit shall not affect operation of other circuits.
5. Alarm activation of any initiation circuit shall not prevent subsequent alarm operation of any other initiation circuit.
6. System shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.

E. Power Requirements

1. Provide 120 VAC power via dedicated branch circuit in emergency panel.
2. Branch circuit shall have "breaker lock" to prevent accidentally de-energizing of power to fire alarm panel.
3. Provide power surge and transient protection on AC input to be:

a. Feed-through, branch circuit suppressor such as EFI HWM-120 or equal by Leviton, Transector, or approved equal UL listed device.
b. Installed in a listed enclosure near the electrical panelboard and trime excess lead lengths.
c. Provide small coil wound 5-10 turns in 1” diameter and securely tie-wrapped.

4. Provide back-up battery capacity to operate entire system in normal supervisory mode for period of 24 hours with 5 minutes of alarm operation at end of period.
5. The voltage drop for notification circuits shall not exceed 14% of the voltage measured across the batteries at that time.
6. System shall automatically transfer to standby batteries upon power failure.

a. Battery charging and recharging operations shall be automatic.

7. Provide power limited, filtered and regulated battery charger.

a. Charger shall:

1) Be combination high rate/float maintenance type.
2) Charge fully discharged battery to 70% in 12 hours.
3) Monitor for AC fail/disconnect, low/no battery, and high battery level.
4) Include switches and associated LEDs for high rate and AC disconnect.
5) Provide 5 amps of regulated 24VDC for peripheral devices requiring ± 5% regulation and 8 amps at 24VDC for standard peripheral devices.
6) Be compatible with lead acid batteries.

8. External circuits requiring system operating power shall be 24VDC and shall be individually supervised and fused at Control Panel.

F. Smoke Detection Operation

1. Smoke detector alarms shall be processed and reported immediately.
2. Upon building completion, alarm verification shall be added to detector(s) as directed by project engineer.
3. Control Panel shall:

a. Be capable of displaying number of times (tally) detector has gone into verification mode from the system history.
b. Download alarm set point to detector.
c. Determine condition of each detector by comparing detector's value to stored values.
d. Maintain moving average of detectors' smoke chamber value to automatically compensate for dust and dirty conditions.
e. Continuously perform an automatic self-test routine on each detector.
f. Have capability of being programmed for pre-alarm or two-stage function.
g. Clear "detector dirty" trouble after detector has been removed from its base cleaned and replaced.

4. System shall maintain constant smoke obscuration sensitivity for each detector by compensating for environmental factors.
5. Photoelectric detector's smoke obscuration sensitivity shall be adjustable to within 0.3% of either limit of UL window (0.5% to 4.0%) to compensate for any environment.
6. System shall indicate when individual detector needs cleaning. When detector's average value reaches predetermined level, trouble MESSAGE shall be audible and visibly indicated at Control Panel. LED on detector base shall glow steady giving visible indication.
7. For scheduling of maintenance, Control Panel shall generate MESSAGE indication for any detector approaching trouble condition due to dirt or contamination.
8. Operator shall have capability to manually access the following information for each detector:

a. Primary status
b. Device type
c. Present average value
d. Present sensitivity value selected
e. Detector range (normal, dirty, etc.)

9. Values at Control Panel shall be in "percent of smoke obscuration" format so that, no interpretation is required by operator.
10. Operator shall be able to manually control following for each detector:

a. Enable or disable detector
b. Establish alarm sensitivity
c. Control detector's relay driver output

11. It shall be possible to program Control Panel to automatically change sensitivity settings of each detector based on time-of-day and day-of-week. There shall be 3 sensitivity settings available for each detector.

G. Elevator Recall Operation

1. When an elevator lobby smoke detector alarm is activated it shall cause Phase I Emergency Recall Operation according to following sequence:

a. If alarmed detector is on any floor other than main level of egress, elevator car(s) shall be recalled to main level of egress.
b. If alarmed detector is on main level of egress, elevator car(s) shall be recalled to predetermined alternate recall level as determined by Owner.

2. Elevator lobby smoke detector shall annunciate on separate zone from other devices.
3. Zoning shall be done by floor.
4. Upon reset of Fire Alarm Control Panel, elevators shall resume normal operations after key reset of the elevator in the first-floor lobby.

H. Elevator Shunt Trip

1. After elevator shaft or elevator controller heat detector is activated, elevator control panel shall deactivate shunt trip breaker supplying power to elevator.

2. Specific elevator shaft zone shall be put into alarm and sound general fire alarm.

I. System Response

1. Maximum elapsed time from sensing fire at non-smoke detector initiating device or second smoke detector until it is recorded at Control Panel shall not exceed 5 seconds and not to exceed 15 seconds for remote station reporting.

J. Air Handling Unit System Operation/Interface

1. Provide alarm relay interface to air handler starters/VFDs for automatic shutdown as specified in Division 23.
2. Fire Alarm Control Panel shall provide manual control mode to override fire alarm panel's signal so that air handling units can be restarted.
3. A supervised AHU shutdown override switch must be provided in/adjacent to the FACU or as a key-operated function of the remote annunciator panel.
   a. Where a remote key-switch is used, provide an informative engraved label at the FACU regarding this function.
   b. This switch must cause a system “trouble” indication in override position.

K. Sprinkler System Operation/Interface

1. Activation of any standpipe or sprinkler system tamper or water flow switch shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator.
2. Control Panel shall provide differentiation between switch operation and opens and/or grounds on initiation circuit wiring.
3. Pressing acknowledge key will silence audible signal while maintaining supervisory service LED "on" indicating off-normal condition.
4. Restoring valve to normal position shall cause supervisory service audible signal to pulse indicating restoration to normal position.
5. Acknowledge key shall silence audible signal.

L. Manual Evacuation (Drill) Operation

1. Manual evacuation (drill) switch shall be provided to operate alarm indicating appliances without causing other control circuits to be activated.
2. Should true alarm occur, alarm functions would occur.

M. LED and LCD Test Operation

1. Activation of Lamp Test switch shall turn on all LED indicators, LCD display, and the local sounder and then return to previous condition.

N. System Diagnosis

1. System shall include special software to detect, diagnose and report failures and isolate such failures to printed circuit board level.

O. Watch-Dog Timers

1. System shall include independent "Watch-Dog" timers to detect and report failure of any microprocessor circuit, memory, or software.

P. Walk Test Operation

1. Actuation of "Walk Test" switch/program at Control Panel shall activate "Walk Test" mode of system, which shall cause following to occur:

a. Campus Police supervising station circuit connection shall be bypassed.
b. Control relay functions shall be bypassed, such as door holders, elevator capture, fan shut down, etc.
c. Audio and visual circuits shall be bypassed.
d. Control Panel shall show trouble condition.
e. Alarm activation of initiation device shall cause audible signals to sound for 2 seconds.
f. Control Panel shall automatically reset itself after signaling is complete.
g. Momentary opening of initiating or indicating appliance circuit wiring shall cause audible signals to sound for 2 seconds indicating trouble condition.
h. If system becomes inactive for period of longer than 30 minutes, Control Panel shall default to normal fire alarm functions.
i. Activation of any initiation device shall be silently logged as an alarm condition in historical data file.

2. Panel shall have capability of dividing system into distinctive walk test groups, minimum of 8 groups.
3. Provide at owner's request at time of system programming.

Q. Voice evacuation functions:

1. Standard on-board system features shall include:

a. digital voice messaging
b. hand-held push-to-talk microphone with override priority
c. power supply/battery charger

2. The system shall be capable of interfacing with telephone systems for emergency paging announcements.
3. The system shall be wired and page to individual zones based on the zone map.

2.3 ENCLOSURE

A. Provide cabinets of sufficient size to accommodate equipment.

B. Remote fire alarm cabinets in electrical rooms, boxes, etc. shall be sized to house all fire alarm power supplies, relays, etc. as well as consolidation of fire alarm circuits within space.

C. Cabinets shall be protected by a smoke detector.

D. Cabinet shall be equipped with door, with lock.

2.4 CONTROL PANEL

A. Control Panel shall be modular, expandable with solid state, microprocessor based electronics.

B. Control panel shall have an external audio input, capable of accepting an external audio signal sent from a central control system.

C. Control Panel shall provide the following features:

1. Support intelligent (analog) detection devices.
2. Number of initiating device loops required.

a. A minimum of one loop per floor is required with additional loops as required for specified quantity of initiating devices.
b. Each active loop shall include 20% spare capacity.

c. Capacity for spare loop cards in panel.

3. Number of indicating device (Speaker) circuits required for quantity of voice alarm, plus 1 spare circuit for each 10 active circuits. Each active circuit shall include 25% spare capacity.
4. Number of indicating device (strobe) circuits required for specified quantity of strobes plus 1 spare circuit for each 10 active circuits. Each active circuit shall include 25% spare capacity.
5. 80-character liquid crystal display.
6. Printer interface.
7. History log file with minimum of 600 events.
8. Field programmable.
9. Drift compensation.
10. Sensitivity display in %.
11. Sensitivity adjustment.
12. Day/night sensitivity adjustment.
13. Auto detector test.
14. Alarm verification with tally counter.
15. Silent walk test.
16. Maintenance alerts.

D. System shall provide ability to recall alarms and trouble conditions in chronological order.

E. Under normal condition viewing window shall display "System is Normal" message and current time and date.

F. When an abnormal condition occurs appropriate LED (Alarm, Supervisory or Trouble) shall flash.

G. Audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

H. Panel shall display the following information relative to abnormal condition of a point in system prior to acknowledgement:

1. 40 characters for:

a. Point address and loop number.
b. Type of device (i.e. smoke, pull station, water-flow).
c. Point status (i.e. alarm, trouble).

2. 40 characters for:

a. Custom location label (i.e. 4th Floor - Room 444)

I. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.

J. Following software functions shall be provided:

1. Setting of time and date
2. LED testing
3. Alarm, trouble, and abnormal condition listing
4. Enabling and disabling of each monitor point separately
5. Activation and deactivation of each control point separately
6. Changing operator access levels
7. Walk Test enable
8. Running diagnostic functions
9. Displaying historical logs
10. Point listing

K. Following hardware functions shall be provided:

1. Acknowledge alarm or trouble
2. Silence alarm or trouble
3. Reset system after alarm
4. Connect/disconnect supervising station tie
5. Provide manual evacuation (drill)
6. Bypass elevator recall and shunt trip operation shall be a software function and password protected.
7. Bypass door holders
8. Allow computer interface

2.5 STATUS INDICATORS AND DISPLAYS

A. Audible device shall sound during Alarm, Trouble or Supervisory conditions.

B. Audible device shall sound during each key-press.

C. Visual display shall distinguish between alarm, trouble and supervisory conditions.

D. Indicators and displays to be visible:

1. One red system alarm LED
2. One yellow supervisory service LED
3. One yellow trouble LED
4. Green "power on" LED
5. Eighty-character LCD

E. 2-line by 40-character LCD shall be backlit.

F. Cursor shall be visible on LCD when entering information.

G. Scrolling through menu options shall be in self-directing manner in which prompting messages shall direct user.

H. Controls shall be located behind an access door.

I. Status data to be available on display:

1. Initiating device circuits
2. Indicating device circuits optional
3. Auxiliary relays
4. Primary State of point
5. Zone information
6. Class "A" Status
7. Current priority of outputs
8. Disable/Enable status
9. Automatic/Manual Control Status of output points
10. Acknowledge status

2.6 CONTROLS

A. Controls (one switch per function per system) visible through front viewing window:

1. Alarm Acknowledge key
2. Trouble Acknowledge key
3. Alarm Silence key

4. System Reset key

B. Controls accessible with front door open:

1. Manual evacuation (drill)
2. Elevator bypass
3. Fan shut down override/bypass switches
4. Door holder release bypass
5. Key pad for data input and microprocessor control

C. DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

1. DACT shall:

a. Be compatible with the central alarm receiving system used by the University.
b. Utilize dual cellular and shall be powered through external transformer plug-in module.
c. Be equipped with backup batteries with an automatic battery charging circuit.
d. Be capable of performing a self-test every 24 hours. Any failure shall initiate a trouble condition.
e. Be capable of generating and sending a 24-hour test report to the receiving station equipment.
f. Provide Napco Starlink dual cellular model SLE-LTEVI-FIRE

2. Integral DACT shall be acceptable only after total compatibility with Owner’s receiving station equipment is demonstrated and verified by Owner.
3. Provide a DACT which is fully compatible with the Owner's Proprietary alarm receiving equipment or the listed central station as indicated on the Drawings. DACT’s requiring programming of Electronic memory (PROM “burn in”), are not acceptable. Connect each DACT to the dual cellular unit. Communicator shall be programmable, dual line and capable of daily report. System shall be capable of proper call in, signal exchange and disconnect with the University’s receiving station, using the contact ID format. The vendor must provide all equipment, software and training necessary for the University to program or reprogram the unit at no cost to the University.
4. DACT shall be 4 channel (minimum) for transmission of fire alarm, supervisory, waterflow, and trouble signals.
5. Fire Alarm System AC Power Trouble (when outage is maintained for 6 hours or more to avoid nuisance transmissions due to momentary 120 VAC power outages or alarm verification cycles)
6. The precedence of signals transmitted to the Supervising Station shall be as follows:

a. Fire Alarm
b. Trouble Signal
c. Water-flow
d. Supervisory Signal

7. Provide addressable monitor module for general DACT supervision.

2.7 LED SUPERVISION

A. Slave module LEDs shall be supervised. When problem occurs LCD shall display module and LED location.

2.8 ACKNOWLEDGMENT

A. Two methods of acknowledgment for each abnormal condition shall be provided:

1. Acknowledge one event at a time from an unacknowledged list of events.

2. Pressing acknowledge button shall display first unacknowledged condition in list (either alarm, supervisory or trouble), and require another acknowledge button. Press to acknowledge only displayed point.

B. After all points have been acknowledged, LEDs shall glow steadily, and alarm will be silenced. Total number of alarms, supervisory and trouble conditions shall be displayed.

C. Pressing appropriate acknowledge button shall acknowledge all points

D. Acknowledge functions shall be behind locked door or pass-code protected.

2.9 SILENCING

A. If an alarm condition exists and "Alarm Silence" button is pressed, all alarm signals shall cease operation. Strobes shall remain active until system is reset.

B. If trouble conditions exist in system and "Trouble Silence" button has been pressed, audible trouble signal shall cease, but shall resound at timed intervals to act as reminder that fire alarm system is not in normal operating mode.

2.10 RESET

A. SYSTEM RESET button shall be used to return system to normal state after alarm condition has been remedied.

B. Should an alarm condition continue to exist, system shall provide indications that resetting cannot be completed and shall remain in an abnormal state.

C. Sonalert and Alarm LED shall remain activated.

D. Display shall indicate total number of alarms and troubles present in system along with prompt to use ACK keys to review points.

E. Points shall not require acknowledgment if they were previously acknowledged.

F. Should Alarm Silence Inhibit function be active, system shall ignore all key presses. An indication of enabling and disabling inhibit state shall be provided as feedback to operator.

2.11 ACCESS LEVELS

A. Provide 2 access levels with level 2 being highest level. Coordinate with and provide passwords as directed by UNCW staff.

B. Pass-codes shall consist of up to 8 digits.

C. Pass-code digits entered shall be displayed as an "X" to indicate that digit has been accepted.

D. Key presses shall be acknowledged by local audible sound.

E. When correct pass-code is entered, system shall indicate to operator "Access Granted".

F. Access level shall be in effect until operator manually logs out or keypad has been inactive for 5 minutes.

G. Operator entering invalid code shall be notified with message, "Incorrect Pass- Code", and shall be allowed 3 chances to enter valid code. After 3 unsuccessful tries, the message, "Access Denied", shall be displayed.

H. Following keys/switches shall not have associated access levels:

1. Alarm Silence
2. System Reset

I. Following keys/switches shall have associated access levels:

1. Set Time/Date
2. Manual Control
3. On/Off/Auto Control
4. Disable/Enable
5. Programming functions
6. Clear Historical Alarm Log
7. Clear Historical Trouble Log
8. Walk Test

J. Acknowledge keys shall not require pass code access to acknowledge points.

2.12 POINT LISTING

A. Point list menu includes:

1. All points list by address
2. Monitor point list
3. Signal/Speaker list
4. Auxiliary control list
5. Feedback point list

2.13 HISTORY LOGGING

A. System shall be capable of logging and storing the last 400 events (alarm and trouble) in history log. These events shall be stored in battery protected random access memory.

B. Following historical alarm log events shall be stored:

1. Alarms
2. Alarm Acknowledgment
3. Alarm Silence
4. System Reset
5. Alarm Historical log cleared

C. Following historical trouble log events shall be stored:

1. Trouble conditions
2. Supervisory alarms
3. Trouble acknowledgment
4. Supervisory acknowledgment
5. Alarm Verification tallies
6. Walk Test results
7. Trouble Historical log cleared

2.14 COMPUTER INTERFACE

A. CPU shall monitor all alarms and troubles and control selected functions of Control Panel.

B. CPU shall supervise all data communication wiring between CPU and Control Panel for opens, shorts and grounds.

2.15 FIELD PROGRAMMING

A. System shall be fully programmable, configurable, and expandable in field and shall not require replacement of memory IC's.

B. Programming may be accomplished through Control Panel keyboard or keyboard at printer or use of PC.

C. Programs shall be stored in non-volatile memory.

D. Programming or reprogramming shall be done by supplier at no charge until system is accepted by Owner.

2.16 TERMINAL/PRINTER INTERFACE

A. Control Panel shall be capable of operating remote monitors and/or printers.

B. Output shall be ASCII from RS-232-C connection with an adjustable baud rate.

C. Each RS-232-C port shall be capable of supporting and supervising up to 4 remote CRTs and Printers.

D. Data amplifiers shall be used to increase CRT or printer line distance.

2.17 INTELLIGENT NETWORK

A. System shall provide communications with intelligent initiating and control devices individually.

B. Devices shall be individually annunciated at control panel.

C. Annunciation shall include the following conditions for each point:

1. Alarm
2. Trouble
3. Open
4. Short
5. Device missing/failed

D. Devices shall have capability of being disabled or enabled individually.

E. There shall be no limit to number of detectors, stations, or addressable modules, which may be activated or "in alarm" simultaneously.

F. Multiple intelligent devices shall be connected to a single pair of wires.

2.18 REMOTE ANNUNCIATOR PANEL

A. Provide 80-character LCD remote annunciator panel.

1. LED annunciators will not be accepted.

B. Annunciator shall provide:

1. Control push-button switches for; alarm silence, trouble silence, system reset and LED and LCD test.
2. Tone Alert - Duplicates Control Panel tone alert during alarm and trouble conditions
3. System trouble LED
4. System alarm LED
5. Power on LED

C. Annunciator shall communicate to Control Panel over one shielded twisted pair cable.

D. Operating power shall be 24VDC and be fused at control panel.

E. Annunciator shall have white or black finish.

F. Wiring between annunciator panel and Control Panel shall be supervised for opens, grounds and shorts.

G. Under normal operating conditions, LCD shall indicate time, date and "SYSTEM IS NORMAL" label.

H. During abnormal conditions, LCD shall indicate type and number of abnormal conditions such as alarms, troubles, and supervisory services.

2.19 EMERGENCY VOICE / ALARM COMMUNICATIONS

A. System shall have Emergency Voice / Alarm Communications capability, including one-way voice (PA) Communications system.

B. One-way voice / alarm (PA) installations shall be dual-channel, permitting the transmission of an evacuation signal to one of 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:

C. Each floor stairway, elevator bank and assembly space (>300 occupants) 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 to meet sound level requirements.

D. Normal audio amplifier power shall be minimum of 125% RMS 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 (or one watt per speaker, whichever is higher). Provide a copy of this calculation with the shop drawing submittal to the Designer. Also include on the "calculations" sheet included as part of the as-built drawings.

E. Provide at least one backup amplifier, tone generator and pre-amp for each channel, equal in power to the largest channel requirement. 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.

F. The audible emergency evacuation signal shall comply with NFPA 72. 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.

G. 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 equivalent in larger AWG size, 7 strands maximum. 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 the system manufacturer.

H. The failure of equipment or a fault on one or more conductor of one notification appliance circuit shall not result in a functional loss of any other notification appliance circuit.

I. Communications equipment shall be housed in the FACP and/or in adjacent cabinet(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.

J. Evacuation signal shall be a “three-pulse” temporal pattern complying with ANSI S3.41-1990. Consult with UNCW on message for evacuation.

2.20 MULTIPLEXED PERIPHERAL DEVICES

A. Devices shall be supervised for trouble conditions.

B. Failure of device shall not hinder operation of other system devices.

C. Device Identification

1. Each intelligent device shall be identified by an address code to include addressable loop number and device number.
2. Location of end-of-line device shall be indicated on device that containing same.
3. System must verify that proper type device is in place and matches software configuration.

D. Intelligent Detector Bases

1. Either base or head shall contain electronic circuits that communicate detector's status (normal, alarm, sensitivity status, trouble) to Control Panel over two wires. Same 2 wires shall also provide power to base and detector.
2. Contacts between base and head shall be of bifurcated type using spring-type, self-wiping contacts.
3. Base shall have locking capability. Locking feature must be field removable when not required.
4. Upon removal of detector's head, trouble signal shall be transmitted to Control Panel.
5. Detector base shall be sealed against rear airflow entry.
6. Detector base or head shall contain LED(s), which shall flash when detector is being scanned by Control Panel.
7. LED(s) shall turn on steady when detector is in alarm condition.

E. Intelligent Detector Heads - General

1. Intelligent detector heads shall be low-profile type.
2. Heads shall be plug-in units, which mount to common base.
3. Heads shall be 24VDC type.
4. Heads may be reset by actuating Control Panel reset switch.

5. To minimize false alarms, voltage and RF transient suppression techniques shall be employed.
6. Smoke detectors shall:
    a. Be listed for sensitivity testing from Control Panel. Sensitivity test results shall be logged and downloaded to printer.
    b. Include an insect screen.
    c. Communicate actual smoke chamber values to Control Panel.
    d. Be covered with plastic bags or caps after installation to maintain cleanliness. Covers shall be red or orange for quick visual identification for removal at time of occupancy.

F. Intelligent Ionization Smoke Detectors

1. Detectors shall:
    a. Be of dual chamber type: one chamber for sampling, and one chamber for reference.
    b. Sense product-of-combustion and report measured level of such products in analog form to control panel.
    c. Detectors used in the data center hot aisle containment shall be rated for 4000fpm.

G. Intelligent Photoelectric Smoke Detectors

1. Detectors shall:
    a. Contain no radioactive material
    b. Be of solid state photoelectric type and shall operate on light scattering photodiode principle using pulsed infrared LED light.
    c. Detectors used in the data center hot aisle containment shall be rated for 4000fpm.

H. Intelligent Heat Detectors

1. Detectors shall:
    a. Be combination rate-of-rise and fixed temperature (adjustable 135°F - 174°F unless noted).
    b. Sense within temperature range of 32°F to 158°Control panel shall be capable of sensing either set point of 135°F, or rate-of-rise of 15°F per minute for fire sensing.

I. Intelligent Duct Smoke Detectors

1. Duct detectors shall be of photoelectric type.
2. Detectors shall be rated for air velocity to be expected.
3. It shall be possible to alarm duct detector by using remote or local test switch.
4. It shall be possible to clean sampling tubes by access through duct housings front cover.
5. Provide remote keyed test switch.
6. Provide LED Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label.
7. Duct detector sampling tubes shall extend the full width of the duct. Those over 36” long must be supported at the far end.
8. Each duct detector must be accessible within the duct by a 12”x12” minimum hinged, latched duct access panel. Indicate airflow direction on the duct using stencil or permanent decal.
9. Activation of any duct smoke detector shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator.

J. Air Aspiration Duct Smoke Detectors

1. Duct detectors shall be of photoelectric type.
2. Provide air sampling tubes for remote access into ducts in chases where regular duct detectors are not accessible.
3. Microprocessor controlled aspiration system with adjustable air speed settings, monitoring of airflow in ducts, air filter element and remote function air testing.

4. Air draws from the duct thru sampling holes in duct-mounted sampling tubes. Sample air is analyzed by sensor.
5. Provide remote test switch in easily accessed area.

K. Beam Smoke Detectors

1. Provide transmitter and receiver type smoke detectors at the locations shown on the drawings. This detector shall consist of an integrated transmitter and receiver capable of being powered separately or together.
2. The detector shall operate in a short range of 15 to 160 ft**.** The detector shall feature a bank of alignment LEDs on both the receiver and transmitter to ensure proper alignment without the use of special tools. There shall be an integral alignment laser located in the receiver.
3. The detector shall utilize an automatic gain control to compensate for gradual signal deterioration from dirt accumulation on lenses. The beam smoke detectors shall be powered from the system control panel. Testing shall be carried out using calibrated test filters.
4. Provide a remote key activated remote test station for each beam detector. Exact location to be determined by architect in finished spaces or located below transmitter in mechanical/electrical/unfinished spaces in a readily visible location.

L. Manual Stations

1. Manual stations shall:
   a. Be double action.
   b. Be constructed of high impact, red Lexan with raised white lettering and smooth high gloss finish.
   c. Contain circuits that communicate station's status (alarm, normal) to Control Panel over 2 wires.
   d. Mechanically latch upon operation and remain so until manually reset. Stations, which use Allen wrenches or special tools to reset shall not be accepted.
   e. Be fitted with screw terminals for field wire attachment.
2. Address shall be field programmable on station.

M. Interface Modules - General

1. Interface Modules shall:
   a. Receive 24VDC power from separate two wire circuit.
   b. Be available in either Class B or Class A supervision version.
   c. Be supervised and identified by Control Panel.
   d. Be capable of being programmed for its "address" location.
   e. Be compatible with addressable manual stations and intelligent detectors on same intelligent initiating circuit.
2. Class A wiring shall be looped back and connected to module.
3. Class B wiring shall be supervised by an end-of-line device.
4. Should interface module become non-operational or removed, trouble signal shall be transmitted to Control Panel.
5. Interface module LED's shall be clearly visible on the face of the trim plate.

N. Interface Modules - Supervised Control

1. Interface Modules shall be used for control of indicating appliances, door holders, and AHU systems.
2. For signals, speakers, fire fighter phone jacks and other device control interface module shall provide double-pole/double-throw relay switching that can connect any of the following through 2-amp fuses:

a. Zone of signals to power source
b. Speakers to audio source
c. Variety of controlled devices to appropriate controlling circuits.

3. Interface modules shall:

a. Communicate supervised wiring status (normal, trouble) to fire alarm control panel.
b. Receive from fire alarm control panel command to transfer relay.

O. Interface Modules - Supervised Monitoring

1. Interface Modules shall:

a. Be suited for monitoring of water-flow, valve tamper, and non-intelligent detectors.
b. Addressable interface module shall be provided for interfacing normally open direct-contact devices to an intelligent initiating circuit.
c. Provide power to and monitor status of zone consisting of conventional 2-wire smoke or heat detectors and N/O contact devices.
d. Communicate zone's status (normal, alarm, trouble) to Control Panel.

2. Supervision of zone wiring shall be Class B or Class A.

P. Interface Modules - Non-Supervised Control

1. Interface module shall provide double-pole/double-throw relay switching for loads up to 120VA.

a. Addressable Monitor Module:
b. Addressable Monitor Modules shall be provided to connect (1) one non-addressable device or to supervise a non-addressable IDC zone (either Style D or Style B) of conventional 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: Unless otherwise indicated on the Drawings an LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the FACP.
2) Mounting Requirements: Monitor Modules shall be mounted in a standard 4-inch square, 2-1/8" deep electrical box at the height between 48-80 inches AFF in a clearly visible location.
3) Addressable monitor modules must be located in conditioned space, unless they are tested, listed and marked for continuous duty across the range of temperatures and humidity expected at their installed location.

c. Addressable Control Module: Addressable Control Modules shall be provided to supervise and control the operation of (1) one conventional Notification Appliance Circuit (NAC) of compatible, 24 VDC powered, polarized Audio/Visual (A/V) Notification Appliances.

1) For fan shutdown, and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2) The control module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device.
3) 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.
4) Control modules shall be rated for the load they control. (Inductive Loads require inductive rated modules.)
5) Mounting Requirements: Control Modules shall mount in a standard 4-inch square, 2-1/8" deep electrical boxes at the same height as Notification Appliance devices

and shall only be installed in conditioned spaces which does not exceed listed parameters for the device. Device shall be mounted with appropriate device cover plate to maintain visibility of device LED with cover in place at a height between 48-80 inches AFF.

6) Configuration: The control module NAC circuit may be wired for Style Y 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.
7) 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.
8) 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, UL listed remote power supply. A/V power sources and connections are not shown on the Drawings
9) Test Switch: A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring

2. Speaker and strobe circuits shall be zoned two per floor minimum or as noted on plans.
3. Tones

a. Main evacuating tone shall be temporal code-3.
b. Optional tones shall include:

1) Hi/Lo – Free running tone with high frequency of 544Hz, 0.1 seconds run time alternating with low frequency of 440Hz, 0.4 seconds run time.
2) Slow whoop – Slowly ascending tone from 200 to 830 Hz in 2.5 seconds.
3) Wav files of similar duration loaded onto the system.

c. 1 primary and 1 secondary tone generator shall be furnished.

1) Automatic transfer to secondary unit should primary unit fail.
2) Trouble signals shall indicate failure of either primary or secondary unit.

2.21 AUDIO-VISUAL ANNUNCIATION DEVICES

A. Speakers shall have the following features:

1. Located as shown on the Drawings. Devices located outdoors shall be listed for use in wet locations. Speakers shall have the following specifications:
2. Voltage: 24 VDC or 70VDC nominal.
3. Field adjustable audible intensity without the use of special tools, to provide varying audio production power of 1/8W, 1/4W, 1/2W, 1W and 2W.
4. Mounting: Provide surface mounting devices suitable for mounting in a standard recessed device box unless otherwise indicated on the Drawings. Wall mounted speakers without strobe lights are to be located so the top of the device is not less than 90” AFF, and at least 6” below finished ceiling (BFC).
5. Audible signals must comply with current ADA requirements and NFPA 72 for intensity and placement.

B. Strobes shall have the following features:

1. Multi-tap units with taps at 15, 30, 75 and 95(ceiling)/110(wall) candela.
2. Wall-mounted devices shall be tapped at 15cd in corridors, 75cd elsewhere, or as noted on drawings.
3. Ceiling-mounted devices shall be tapped at 30cd for ceiling heights less than 10-ft, 75cd for mechanical equipment rooms and ceilings greater than 10-ft.
4. Colorless Lexan lens.

5. Have flash synchronization module on all circuits.
6. Served by new power supplies.

C. Horns:

1. Operate on 24V DC circuit
2. Include separate wire leads for in/out wiring for each leg of associated signal circuit. T-tappings of signal device conductors shall not be acceptable.
3. Be suitable for rear mounting behind audio-visual assemblies, which shall be flush or semi-flush mounted, with manufacturer back boxes and flush trim ring.
4. Have field adjustable output taps, 3 taps minimum.
5. Provide minimum sound pressure level of 85.7 dBA at 10 feet using 1-watt tap.
6. The standard audible evacuation signal is the ANSI S3.41 three-pulse temporal pattern.
7. Horns located in mechanical rooms shall have:

   a. 3 taps minimum with 8W being the highest.
   b. minimum sound pressure level of 90 dBA at 10 feet using 2-watt tap.

8. Include blocking capacitor for line supervision and screw terminal for in-out wiring.

D. Combination speaker/strobe devices shall have all applicable features of speakers and strobes and the ability to silence the speaker while maintaining operation of the strobe.

E. Circuiting:

1. Provide for synchronization of all strobes visible from one location including the very expansive atrium.
2. Speakers and strobes shall operate on separate supervised circuits.
3. Strobe circuit loading shall be calculated at 75cd tap for all devices.

F. Device housings:

1. The word "FIRE" printed on faceplate visible from 180° field of view.
2. Wall devices shall have red semi-flush housing with white lettering.
3. Ceiling devices shall have off-white semi-flush housing with red lettering.
4. Cast metal grille and back box where installed in mechanical/interstitial spaces.
5. Surface-mounted devices shall have matching backbox furnished by device manufacturer.
6. Ceiling-mounted devices are only permitted where indicated on plans. Do not substitute ceiling mounted devices for wall-mount without permission from the Architect in writing.

G. Additional strobe power can be obtained via a combination of boosters.

H. The strobe section of the booster shall be divided into two sections each supplying two Amps of 24VDC, NAC, supervised, synchronizable, power limited, Class B strobe outputs, with selectable outputs offering manufacturer’s sync, pass through, or constant DC and can be activated via 8-33VDC NAC input or contact closure.

2.22 4 ZONE CLASS B SPEAKER SPLITTER

A. Splitter shall enable a single supervised speaker audio output to drive up to two Class A supervised speaker audio outputs or four Class B supervised speaker audio outputs.

B. Each Class A zone shall be capable of accepting up to 40 watts and operate on either 25 or 70.7V RMS of audio input.

C. Each Class B zone shall be capable of accepting up to 40 watts of audio and operate on either 25 or 70.7V RMS of audio input.

D. The splitter shall mount inside the audio booster enclosure and shall have power and trouble LED's with individual zone short and open LED indication.

E. The splitter shall be capable of detecting wiring faults.

F. The splitter shall be powered by 24VDC supplied by the audio booster.

G. Standby and Alarm current at 24VDC shall be 15mA.

H. Removable wiring terminals for quick connect/disconnect accepting 12–22 AWG shall be incorporated.

I. All output circuitry shall be power limited.

J. Space shall be provided to allow for naming of the zones.

2.23 CONVENTIONAL PERIPHERAL DEVICES

A. Sprinkler Waterflow Switches - Wet Systems

1. To be furnished and installed by Fire Protection Contractor under Division 21.
2. To prevent false alarms, flow switch shall incorporate adjustable time delay mechanism between the paddle-operated stem and alarm initiating contacts.
3. Tapped 1/2" conduit connection.

B. Sprinkler Valve Tamper Switches - Wet Systems

1. Sprinkler valve tamper switches shall be furnished and installed by Fire Protection Contractor under Division 21.
2. Switch shall be provided with either 1 or 2 sets of S.P.D. micro switches as required.

C. Door Holders

1. Magnetic door holders shall:

   a. Be provided by the General Contractor.
   b. Be capable of being surface, flush, or semi-flush mounted as required.

2. Door holders shall be powered at 24 volts from the FACP.
3. Door holder current drain shall be included in the battery calculations.

D. Line Isolator Module

1. Provide Line Isolator Module (LIM) on initiating device circuits:

   a. Between every 20 or fewer devices on a loop.
   b. In or immediately adjacent to the FACU and at each end of the addressable loop located in the same room as the FACP and within 15ft.
   c. At terminal cabinets on each floor.

2. Line Isolator Module shall:

   a. Automatically re-connect isolated section of loop upon correction of fault conditions.
   b. Not require any address setting
   c. Operations shall be totally automatic. It shall not be necessary to replace or reset LIM after its normal operation.

d. Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.
e. Isolator modules shall not be installed above ceilings or more that 84 inches above finish floor. Isolator bases are acceptable on detectors installed on ceiling heights 8 feet or less.

2.24 PRINTERS

A. Multiplex/intelligent systems shall be provided with printer and terminal (keyboard and CRT).

B. Printer

1. Desktop 80-column, impact dot matrix printer.
2. Printer shall receive English language text from Control Panel in standard ASCCII format via RS-232-C connection.
3. Printed information shall include time, date, status, point number, label, and device type identifier.
4. Printer shall have the following features:

a. 120 VAC input power
b. 180 characters per second printing speed
c. 3 kilobytes buffer capacity
d. Cartridge type ribbon
e. Friction feed for cut forms
f. Tractor feed for continuous 9-1/2" wide pin-to-pin fanfold paper

5. Provide a sturdy table for the printer.

PART 3 - EXECUTION

3.1 GENERAL

A. Class A wiring for initiating device and Class B wiring for notification device circuiting shall be used.

B. Installation shall be done in neat, workmanlike manner in accordance with manufacturer's recommendations.

C. Smoke detectors shall not be mounted until construction is completed.

D. A speaker shall be installed in stairwells, located on a landing that is centered vertically in the enclosure.

E. Exterior exit locations and appropriate congregation areas (i.e., balconies, patios, walkways) shall have a fire alarm (white) strobe and a horn loud speaker.

3.2 RACEWAYS

A. Fire Alarm Panel risers and horizontal distribution shall be in conduit system, separate from other building wiring.

B. Wiring shall be in conduit system separate from other building wiring. See Section 26 0533 - Raceway and Boxes for Electrical Systems.

C. Minimum 3/4" steel raceway.

D. Contractor shall size conduit and boxes by circular mil size of cable in conduit or box.

3.3 CONDUCTORS

A. Cables and wires shall be provided per manufacturer shop drawings.

B. Conductors shall be color-coded. Coding shall be consistent throughout facility.

C. Green wire shall be used only for equipment ground.

D. Control Panel power wiring shall be #12 AWG.

E. Control Panel shall have #12 AWG equipment ground wire.

F. Provide 2-hour rated cable for riser cable.

G. All 120-volt circuits used for fire alarm shall be locked in the on position.

H. The following protection against voltage transients and surges must be provided by the fire alarm equipment supplier, and installed by the electrical contractor at each panel or SNAC panels:

1. On AC Input: A feed-through (not shunt-type) branch circuit transient suppressor such as the EFI E100HW120, Leviton 51020-OWM, Emerson/Northern Technologies TCS-HWR, Transtector ACP100BW series, or any equivalent UL 1449 - 2nd Edition Listed device submitted to and approved by the electrical design engineer. Install 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.
2. On DC Circuits Extending Outside Building: Adjacent to the FACU, and also near point of entry to outlying 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. Some acceptable models: Innovative Technology D2S33-2ML, Simplex 2081-9027/-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel America B280-24V, Leviton 3824-OWM, Northern Technologies DLP-Submit data on others to the engineer for approval. UL 497B listing is normally a prerequisite for their consideration. Devices using only MOV active elements are not acceptable.
3. Provide #10 ground conductor from ground bus of nearest panelboard to bond enclosure and all surge protection device ground terminals.

I. Cable Detector Loops shall be twisted pair with shield jacket. Shield shall be connected to earth ground only at control panel. Unshielded twisted pair shall be allowed where required by the manufacturer for SLC loop.

J. Detector wiring shall not be in same conduit with 120/240 VAC wiring or other high current circuits. Conductors of other systems regardless of voltage or current are not permitted in the same raceway as fire alarm conductors/cables. Examples are but not limited to elevator recall circuits, door release circuits, AHU shutdown circuits, etc..

K. Leave 8" wire tails at each device box and 36" wire tails at Control Panel and Remote Annunciator Panels.

L. Cable for RS 232-c devices (CRT, PRINTER) shall be two, shielded twisted pair.

M. Cable for RS 485 devices (Remote Annunciators) shall be shielded-twisted pair for data signal.

N. Connections shall be made within approved junction boxes and with approved fittings.

O. Boxes shall be red and labeled "FIRE ALARM SYSTEM" by decal or other approved markings.

P. Speaker and strobe circuits shall have separate conductors and shall operate independently of each other. Alarm notification appliance (NAC) circuits shall be NFPA 72 Style Y (Class B). The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 1 floor (to limit the effect of faults, and to facilitate trouble-shooting). The NAC voltage drop during alarm must not exceed 14% of the voltage measured across the batteries at that time.

Q. All cabling must be run in conduit. Tray cable is not acceptable for use as fire alarm systems raceway.

R. There shall be no splices in the system other than ad device terminal blocks or on terminal blocks in cabinets. “Wire nuts” and crimp splices will not be permitted.

S. 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.

T. Addressable loop circuits shall be wired with type FPL/FPLR/FPLP, #18AWG minimum, low capacitance (less than 30pf/linear foot), twisted shielded copper pair, fire alarm cable.

U. All wiring other than signaling circuits are to be minimum #14AWG, THHN/THWN conductors color-doded as follows:

1. Alarm notification appliance (speakers and strobes) circuits shall be blue(+)/black(-).
2. Separate 24VDC operating power for equipment shall be yellow(+)/brown(-).
3. Door control circuits shall be orange.
4. Circuits from ZAMs to monitored devices shall be violet (+)/gray(-).

V. All junction box painting shall be performed prior to pulling wires. Provide pre-painted red conduit. All fire alarm cabling shall be in conduit.

3.4 DEVICE MOUNTING

A. Control panels, power supplies, amplifiers, terminal cabinets, and other control equipment enclosures shall be mounted so that the top of the enclosure is 72 inches maximum above finish floor. Power supplies, terminal cabinets, and other control equipment enclosures shall not be installed above ceilings.

B. Recommended mounting heights, and requirements are as follows:

1. Fire Alarm Control Panels
   a. Mount control panel so visual indicators and controls at 60" above floor level.
2. Remote Annunciators
   a. Mount panel so visual indicators and controls at 60" above floor level.
   b. Install multi-gang box as required by manufacturer, flush or surface mounted.
3. Audio-Visual Devices
   a. Install flush, or surface mount 6" below finished ceiling or 80" from bottom of device to finished floor.
   b. No devices protruding 4" or more shall be installed lower than 80".
   c. Audio/visual devices may be installed on the ceilings in accordance with NFPA 72 - Table 2-A.
   d. For surface mounting, use manufacture-supplied backboxes and trim plates.
   e. Mark each device with its circuit number.

4. Manual Stations
   a. Operable part of manual stations shall be installed not less than 3-1/2 ft (42") and not more than 4-1/2 ft (54”) above finished floor.
   b. Manual stations shall be in unobstructed locations.
   c. For surface mounting, use manufacturers supplied backboxes and trim plates
   d. Mark unit’s address on inside and outside of housing.
5. Heat and Smoke Detectors
   a. Location of detectors shown on plans is schematic only. Detectors must be located according to code requirements.
   b. Surface mounted detectors shall be installed using back boxes equal to base size. Standard octagon and square boxes are not acceptable.
   c. Detectors shall be located on the highest part of smooth ceiling so that edge of detector is no closer than 4" from sidewall.
   d. Ceilings with beams, joists or soffits that exceed 8" in depth require special planning and closer spacing.
   e. Mount detectors on sidewalls with top of detector no closer than 4" from ceiling and no further away than 12".
   f. Smoke detectors shall not be installed closer than 3 ft from air supply diffusers.
   g. No detectors shall be installed in direct airflow.
   h. Heat and smoke detectors should be located near center of open area, which they protect.
   i. Locate detectors within 15’ measured horizontally from FACP and terminal cabinets.
   j. Mark zone number and ranking of each detector on its base.
   k. For intelligent systems, mark address and loop number on each detector's base.
6. EOL Resistors: Maximum height 84”.

3.5 IDENTIFICATION LABELS

A. Junction boxes shall be painted red and labeled "Fire Alarm".

B. Circuits must be labeled with name of circuit and area being served by circuit.

C. Labels shall be permanent, and be machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

D. Labels shall be self-laminating, white/transparent vinyl and be wrapped around cable.

E. Flag type labels are not allowed.

F. Labels shall be of adequate size to accommodate circumference of cable being labeled and properly self-laminate over full extent of printed area of label.

G. Adhesive type labels not permitted except for phase and wire identification.

H. Wiring color code shall be maintained throughout installation.

I. Green wire shall be used only for equipment ground.

3.6 MANUFACTURER'S SERVICES

A. Supervision of installation shall be provided by trained service technician from manufacturer of fire alarm equipment.

B. Technician shall be US certified and have had minimum of 2 years of service experience in fire alarm industry.

C. Technician's name shall appear on equipment submittals and letter of certification from fire alarm manufacturer shall be sent to project engineer.

D. Manufacturer's service technician shall be responsible for following items:

1. Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired.
2. Make periodic job site visits to verify installation and wiring of system.
3. All connections to the FACP and system programming shall be done only by the manufacturer's technician or by an authorized distributor that stocks a full compliment of spare parts for the system.
4. Installing technician must be trained and individually certified within previous 24 months by the manufacturer for the FACP model being installed.
5. At time of final checkout, technician shall give operational instructions to Owner and/or his representative.
6. Job site visits shall be dated and documented in writing and signed by electrical contractor.
7. Discrepancy shall be noted on document and copy kept in system job folder, which shall be available to project engineer any time during project.
8. Certify system to Owner in writing.

3.7 TESTING

A. Manufacturer's authorized representative shall perform complete functional test of each system and submit written report to Contractor attesting to proper operation of completed system prior to final inspection. This report must include program settings for each initiating device and current sensitivity of each analog addressable smoke detector.

B. Contractor shall perform a 100% test of each device in system before system is considered complete. Advance notice of 100% test must be given to Owner and Engineer for opportunity to witness test. The Engineer will then sign NFPA 72 as witnesses of the testing.

C. Testing of smoke detectors is to be accomplished by introducing simulated smoke into the sampling chamber of the detector. Utilizing magnetic test switches to demonstrate system operation will not be acceptable until all device operations have been demonstrated using smoke.

D. The contractor is responsible for providing all materials needed for testing. This includes simulated smoke (approved by manufacturer for use in testing), ladders, two-way radios, keys for access to all equipment and spaces, etc.

E. Test sound pressure levels in mechanical equipment rooms, offices and all public areas. Verify 15dBA above ambient is achieved. Ambient levels are to be considered 55 dB in public areas, offices, & classrooms and 85 dB in mechanical rooms.

F. Contractor shall perform audible notification verification survey and submit a report documenting the ambient sound levels and alarm sound levels for each space within the building.

1. Sound pressure level shall be measured with sound level meter meeting ANSI S1.4a, Specifications for Sound Level Meters, Type 2 requirements. Levels throughout protected area shall be measured and recorded. The sound level meter shall be set in accordance with ANSI S3.41, American National Standard Audible Evacuation Signal, using the time-weighted characteristic F (FAST). Record the maximum output when the audible emergency evacuation signal is on.

G. Contractor to submit to the Engineer the following in advance of 100% test:

1. Completed checklist attached to this specification.
2. Completed NFPA 72- record of completion form

H. Pre-final Inspection:

1. Upon completing the fire alarm system installation, and prior to scheduling the NC State Construction Offices inspections, the contractor and engineer shall conduct a 100% performance test of the entire fully functional system noting any and all discrepancies or deficiencies.
2. Test Report: Upon a successful completion of the performance inspection and correction of all deficiencies, the manufacturer's authorized representative shall issue a test report to the Designer/Engineer, the Construction Management project manager, and University Facilities, detailing and certifying the test, including all requirements as specified or referenced in this document. An inspection by the university can then be scheduled.
3. The engineer or representative, the fire alarm contractor personnel who programmed the system and the electrical contractor shall be present during the test. If at any time there appears evidence that the system was not completely inspected and tested, this test will cease and the process will be repeated.
4. Upon completion of this inspection, the University will issue a punch list. When the punch list has been corrected and all items resolved, a copy of the punch list noting corrective actions is to be submitted to the University. A university representative will return to the project site to verify corrections. Once this has been completed, system acceptance of the system by the Office of State Construction may be scheduled.

I. Upon completion, the contractor is to request the Engineer for final inspection. The system must operate for at least two days prior to this inspection.

J. At the SCO Final Inspection, the contractor shall provides two-way radios, ladders, and other materials needed for testing the system, including a suitable smoke source.

K. The contractor shall provide:

1. System status and programming report generated on the day of system acceptance inspection to include program settings for each initiating device and the current sensitivity of each analog addressable detector.
2. Completed and signed NFPA 72 record of completion form.
3. An HVAC balance report for the smoke control system.
4. As-built drawings and O&M manuals

3.8 DOCUMENTATION AND TRAINING

A. Contractor shall submit as-built drawings and calculations as well as O&M manuals to the owner.

B. Contractor shall provide on compact disc (CD) the complete configuration data for the installed system (site specific).

C. Manufacturer to maintain software version records of the system installed. The system software shall be upgraded free during the warranty period. Any upgrades to correct operating problems shall be provided free.

D. Basic operating instructions shall be framed and mounted at the FACP. The NFPA 72- form is to be located inside the FACP.

E. Provide an engraved label indicating panelboard name and location and circuit serving FACP.

1. Training session shall be at time to be stipulated by Owner.
2. Training shall be completed prior to final inspection.

3.9 WARRANTY

A. Contractor shall warrant completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 2 years from the date of final acceptance of project.

B. Contractor shall post warranty period along with company's name and telephone number inside fire alarm panel.

C. Warranty service for equipment shall be provided by system supplier's factory trained representative.

D. Warranty shall include parts, labor and necessary travel.

E. Non-emergency service calls shall be responded to within 24 hrs of notification to contractor.

F. Repairs and/or replacement shall be completed within 72 hrs of time of notification. Other than emergency, actual repairs and /or replacement shall be provided during normal working hours, Monday through Friday, excluding holidays.

G. If repair and/or replacement cannot be made within prescribed time, other means and methods of protection shall be provided to insure safety of building occupants during which time system is not in compliance with standards. This may involve up to and include hiring Owner approved qualified personnel to stand fire watch, at contractor's expense.

3.10 MAINTENANCE CONTRACT

A. Equipment manufacturer shall make available to Owner, maintenance contract proposal to provide minimum of 2 inspections and tests per year in compliance with NFPA-72 Codes.

3.11 SPARE PARTS

A. Contractor shall include in bid the cost to furnish and install four detection and four annunciation devices per floor beyond that shown on drawings with locations to be determined in the field by the engineer. If unused, a credit shall be provided to the university. This is alternate no. 49.

B. Contractor shall provide to the Owner the following spare parts in quantities shown relative to installed quantity. (Required by SCO) Rounded up to the nearest whole device:

Quantity	Type of Device Present
10%	Photoelectric smoke detectors
10%	Heat detectors
10%	Smoke and heat detector bases
5%	Isolation Modules
10%	Control Modules
4%	Duct detectors with housing and sample tubes
4%	Speaker/strobe Units
4%	Speakers
4%	Strobes
2%	Manual Pull Stations

END OF SECTION 283116

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Brick pavers set in aggregate beds.
2. Aluminum edge restraints.
3. Job-Built Poured in Place Concrete Edge Restraints.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Pavers.
2. Aluminum edge restraints.
3. Aggregate materials.

B. Samples for Initial Selection: For the following:

1. Each type of unit paver indicated.

1.3 QUALITY ASSURANCE

A. Mockups: Build mockups for each form and pattern of unit paver.

1. Approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.4 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.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.

C. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Protect unit paver work against freezing when ambient temperature is 40 deg F and falling.
2. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of setting beds and grout.

PART 2 - PRODUCTS

2.1 BRICK 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. Basis-of-Design Product: The design for brick pavers is based on the Brickwalk brick manufactured by Pine Hall. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

a. Boral Bricks, Inc
b. Triangle Brick Company
c. Or approved equal.

2. Thickness: 2-1/4 inches.
3. Face Size: 3-7/8 by 7-7/8 inches.
4. Edge Style: Square Edge
5. Field Color: Brickwalk red
6. Accent Color: Brickwalk Brown

2.2 ACCESSORIES

A. Aluminum Edge Restraints: L-shaped, 1/8-inch thick by 1-3/8-inch high extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches o.c., and aluminum stakes 12 inches long for each loop.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

a. BRICKSTOP Corporation.
b. Curv-Rite, Inc.
c. Permaloc Corporation.
d. Sure-Loc Edging Corporation.

2. Finish: Mill finish.

B. Job-Built Concrete Edge Restraints: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

2.3 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Division 31 Section "Earth Moving" for Base Course.

B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate, except with no more than 1% passing the No. 200 sieve.

C. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

D. Drainage Geotextile: Nonwoven needle-punched geotextile complying with requirements in Division 31 Section "Earth Moving" for Subsurface Drainage Geosynthetic Materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

B. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.

1. For concrete pavers, a block splitter may be used.

C. Joint Pattern: As indicated.

D. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

E. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.2 AGGREGATE SETTING-BED APPLICATIONS

A. Prepare subgrade according to Division 31 Section "Earth Moving”.

B. Place drainage geotextile over compacted subgrade, overlapping ends and edges at least 12 inches.

C. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

D. Place leveling course and screed to a thickness of 1 inch, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

E. Treat leveling course with herbicide to inhibit growth of grass and weeds.

F. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars.

G. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz.

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.

3.3 UNIT PAVER REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. 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.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION 321400

SECTION 321443 - POROUS UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick Unit Pavers.
2. Aggregate fill.
3. Aggregate setting bed materials.

1.2 ACTION SUBMITTALS

A. Product Data: For materials other than aggregates.

B. Sieve Analyses: For aggregate materials, according to ASTM C136.

C. Samples:

1. Full-size units of each type of unit paver indicated.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A qualified porous unit paving installer. Installer's field supervisor shall have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with PICP (Permeable Interlocking Concrete Pavement) Specialist Designation.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

PART 2 - PRODUCTS

2.1 BRICK UNIT PAVERS

A. Solid Heavy Duty Paving Brick for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C1272, resistant to freezing and thawing when tested according to ASTM C67, and made from normal-weight aggregates.

1. Basis-of-Design Product: The design for Heavy Duty Porous Brick Pavers is based on Heavy Duty StormPave Brick manufactured by Pine Hall Brick. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

   a. Boral Bricks, Inc.
   b. Triangle Brick Company.
   c. Or approved equal.

2. Thickness: 2-3/4 inches
3. Face Size and Shape: 3-7/8 by 7-7/8 inches.
4. Color: Red

B. Solid Pedestrian Brick Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C1272, resistant to freezing and thawing when tested according to ASTM C67, and made from normal-weight aggregates.

1. Basis-of-Design Product: The design for Standard Porous Brick Pavers is based on StormPave Brick manufactured by Pine Hall Brick. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

a. Boral Bricks, Inc.
b. Triangle Brick Company.

2. Or approved equal. Thickness: 2-1/4 inches
3. Face Size and Shape: 3-7/8 by 7-7/8 inches.
4. Field Color: Brickwalk Red
5. Accent Color: Brickwalk Brown

2.2 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with D448 for Size No. 2.

B. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D448 for Size No. 57.

C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.

D. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D448 for Size No. 8.

E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Apparent Opening Size: No. 40sieve, maximum; ASTM D4751.
3. Permittivity: 0.5 per second, minimum; ASTM D4491.
4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 FILL MATERIALS

A. Aggregate Fill for Porous Paving: Graded, sound, crushed stone or gravel complying with ASTM D448 for Size No. 8.

1. Color: As indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.

B. 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.

C. Tolerances:

1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inchunit-to-unit offset from flush.
2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inchesand 1/4 inch in 10 feetor a maximum of 1/2 inch

D. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

3.2 INSTALLATION OF SETTING-BED

A. Compact subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.

B. Place drainage geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

C. Place aggregate subbase, compact by tamping with plate vibrator, and screed to depth indicated.

D. Place aggregate base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.

E. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.

G. Place leveling course, and screed to a thickness of 2 to 2-1/2 inchestaking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.3 INSTALLATION OF PAVERS

A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch-minimum and 1/8-inch-maximum joint width

B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbfcompaction force at 80 to 90 Hz.

C. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.

D. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. 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 321443

SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bollards
2. Bike Racks

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 DECORATIVE BOLLARDS

A. Basis-of-Design Product: The design for decorative bollards is based on the Model #CB-F Decorative Bollard by Olympic Foundry Decorative Products. Subject to compliance with requirements, provide a comparable product by one of the following:

1. DuMor, Inc.
2. Victor Stanley
3. Reliance Foundry
4. Or Equivalent

B. Size:

1. Above Grade Height: 42 inches
2. Overall Width: 12 inches

C. Material: Ductile Iron

D. Mounting: Post Cover – New post in new concrete

E. Finish: Polyester Powder-coat utilizing an epoxy prime coat and a polyester topcoat.

1. Color: Black

2.2 BICYCLE RACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bike Rack 290 manufactured by DuMor, Inc indicated on the drawings or a comparable product by one of the following:

1. Victor Stanley
2. Sunshine U-Lock Corporation
3. Approved Equal.

B. Bicycle Rack Construction:

1. Frame: Schedule 40 Steel tubing

   a. Pipe Tubing OD: Not less than 2-3/8 inches.

2. Style: Inverted "U" form.

   a. Overall Height: 48 inches.
   b. Above Grade Height: 36 inches.
   c. Overall Width: 30 inches.
   d. Overall Depth: Pipe OD.
   e. Capacity: Designed to accommodate no fewer than two bicycles.

3. Installation Method: Embeded.

C. Steel Finish: Powder Coat.

1. Color: Black.

2.3 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211.
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221.
3. Structural Pipe and Tube: ASTM B 429/B 429M.
4. Sheet and Plate: ASTM B 209.
5. Castings: ASTM B 26/B 26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:

1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
6. Expanded Metal: Carbon-steel sheets, deburred after expansion, and complying with ASTM F 1267.
7. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
8. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.

C. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
3. Tubing: ASTM A 554.

D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.

1. Wood Species:

a. Teak (Tectona Grandis): Clear Grade.

2. Finish: Manufacturer's standard

E. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.

2.4 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.5 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.6 STEEL AND GALVANIZED-STEEL FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300

SECTION 328400 - LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. The sprinkler system shall include sprinklers, valves, piping fittings, controller, wiring, all of sizes and types as shown on the drawings and specified. The system shall be constructed to grades and conform to areas and locations as shown on the drawings.

B. Sprinkler lines shown on the drawings are essentially diagrammatic. Spacing of the sprinkler heads or quick coupling valves are shown on the drawings and shall be exceeded only with written permission of the Designer.

C. Unless otherwise specified or indicated on the drawings, the construction of the sprinkler system shall include the furnishing, installing, and testing of all mains, laterals, risers and fittings, sprinkler heads, gate valves, control valves, controllers, electric wire, controls, backflow preventers, enclosures, and other necessary specialties and the removal and/or restoration of existing improvements, excavating and backfill, and all other work in accordance with the plans and specifications a required for a complete system.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Irrigation Contractor shall have successfully completed five (5) projects similar in material, size, scope and complexity to that indicated for this Project that have resulted in construction with a record of successful in-service performance. This requirement includes Pump installation Contractor.

1. Firm Experience Period: Five (5) years of experience
2. Field Foreman Experience: Five (5) years of experience with installing firm.

B. Conference: Before any work is started a conference shall be held between the Contractor and the Owner concerning the work under this contract.

C. The Contractor shall maintain continuously a competent superintendent, satisfactory to the Owner, on the work during progress with authority to act or him in all matter pertaining to the work.

D. It is the Irrigation Contractor’s responsibility to coordinate and cooperate with the other Contractors to enable work to proceed rapidly and efficiently.

E. The Contractor shall confine his operations to the area to be improved and to the areas allotted him by the Designer and General Contractor for material and equipment.

F. Contractor shall take all necessary to protect the existing site conditions and vegetation.

1.3 SUBMITTALS

A. General: Submit in accordance with Shop Drawings, Product Data, and Samples.

B. Shop Drawings and Equipment Product Information:

1. Prior to purchasing materials, submit product information on all sprinkler heads, automatic valves, quick coupling valves, controller, and pipe to be used on the project.
2. Contractor shall review drawings and data to supply actual precipitation rates and times for each zone in maintenance package.
3. Prior to trenching, Contractor shall submit proposed trenching equipment to Designer for approval.

C. Record Drawings and Instructions

1. Upon completion of installation, Contractor shall produce as-built drawings in Autocad 2010 format and furnish one set of reproducible and one set of printed record drawings showing all sprinkler heads, valves, drains, and pipelines to scale with dimensions. These drawings shall have dimensions from easily located stationary points (cross measured) as they relate to all valves, mainlines, and wire. Clearly note all approved substitutions of size, material, etc. Complete, concise instruction sheets and parts lists covering all operating equipment and weathering techniques shall be bound into folders and furnished to the Owner in three (3) copies. Submission of this information is a requirement for final acceptance.

1.4 SITE CONDITIONS

A. The Contractor shall examine the site, plans and specifications (i.e. system requirements).

B. It shall be the Contractor's responsibility to report in writing to the Designer any deviations between drawings, specification, and actual site conditions. Failure to do so prior to the installing of equipment shall be done at the Contractor's expense.

C. Adjustment of the sprinkler heads and automatic equipment will be done by the Contractor, upon completion of installation, to provide optimum performance.

D. After completion, testing, and acceptance of the system, the Contractor shall verbally instruct the Owner's personnel in the operation and maintenance of the system. All written instruction shall be included in the bound maintenance package as stated in Paragraph 1.3 - Submittals.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe sizes shall conform to those shown on the drawings. No substitutions of smaller pipe sizes will be permitted, but substitutions of larger size may be approved. All pipe damaged or rejected because of defects shall be removed from the site at the time of said rejection.

B. All mainline piping (21/2") two and one half inches and larger will be equipped with gaskets.

C. All fittings for mainline pipes two and one half (21/2") inches or larger will be equipped with gaskets.

D. All piping downstream of electric valves, sizes (3) inches and smaller, shall be rigid unplasticized PVC 200 PSI working pressure extruded from virgin parent material of the type specified on the drawings. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles and permanently marked with the manufacture's name, material, size, and schedule type. Pipe must bear the NFS seal.

E. All mainline piping and underground piping under continuous pressure shall be rigid unplasticized PVC-Class 200 PSI working pressure extruded from virgin parent material of the type specified on the

drawings. The pipe shall be homogeneous throughout and free from visible cracks, holes, and foreign materials, blisters, wrinkles and dents.

F. All plastic fittings to be installed shall be molded fittings manufactured of the same material as the pipe and shall be suitable for solvent weld, slip joint ring tight seal, or screwed connections NO fitting made of other material shall be used except as hereinafter specified.

G. Slip fitting socket tapers shall be so sized that a dry unsoftened pipe end conforming to these special provisions can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only Schedule 80 pipe may be threaded.

H. Fittings for all Mainline Piping 4” and larger shall be Harco Ductile Iron Gasketed Fittings. All mainline shall utilize approved thrust blocking and or restraints. Thrust Blocking and restraints to be installed as per manufacturer’s recommendations for pipe type, pipe size and local environmental conditions.

2.2 SLEEVES

A. All sleeves shall be Class 200 PVC or stronger. All sleeves are required at every crossing indicated on drawings. (Size Noted)

B. All sleeves shall be installed under proposed pavement areas prior to subgrade and base construction.

C. Sleeves shall have a minimum horizontal separation of 18” and a maximum of twenty-four (24) inch clearance below bottom of curb.

D. All sleeves shall have a minimum horizontal separation of twenty-four (24) and maximum of thirty-six inches from center to center.

E. Stub up sleeve pipe twelve (12) inches above ground surface and cap. Paint cap with fluorescent orange paint for easy identification.

F. The location of all sleeves shown on the plans is schematic. The contractor shall make any adjustments necessary to accommodate existing vegetation, utilities, or other existing conditions.

G. If the road crossings are designated as being bore locations the bore must be ample size to accommodate the size sleeve specified.

2.3 CONTROL SYSTEM

A. The Controller shall be two-wire, decoder based system (as stated on plans).

B. The automatic controllers shall be as shown on the plans and shall be made by the same manufacturer as valves.

C. Install Rain Check or Mini-Click type shut off device to override the control timer in the event of rain.

2.4 CONTROL WIRE

A. Two-wire Control wire shall be type UF, UL approved, for direct burial and shall be Hunter IDWIRE (#14-2 size minimum, solid copper, double jacked, insulated.

B. Joining of underground wires shall be made with watertight connectors in valve boxes. No splicing between boxes is acceptable. Utilize 3M DBR/Y-6 Connections unless directed otherwise.

C. All wire connections in valve boxes; first example shall stay open until the Designer approves.

D. Install Surge Protection Device every 300 feet or every 6 decoders, whichever is less, with Ground Rod, on two-wire path and at end of wire run that terminates in field (star configuration).

2.5 IRRIGATION VALVES

A. Zone Control Valves

1. Globe-type diaphragm valves of normally closed design, with bronze bodies or heavy- duty plastic and covers (type noted on drawings). Operation accomplished by means of an integrally mounted heavy-duty 24 volt AC solenoid complying with National Electrical Code, Class II Circuit, solenoid coil potted in epoxy resign within a plastic-coated stainless steel housing. Solenoids shall be completely waterproof, suitable for direct underground burial. Provide a flow stem adjustment in each valve.
2. To be installed with Single Station Decoder (as specified on plans).

2.6 VALVE BOXES

A. All valves shall be installed in thermoplastic valve access boxes of the size required to permit access to the valve. Valve boxes shall include black thermoplastic locking covers. Manufacturer - Carson or approved equal.

B. All valve boxes shall be installed on at least a two (2) cubic foot gravel base to provide foundation and drainage.

C. All valve box elevations shall be ½” below finished grade.

2.7 THRUST BLOCKS

A. Place one cubic ft. of concrete for each inch of pipe diameter for thrust block. Thrust shall not allow vertical or horizontal movement of pipe in any direction unless otherwise noted on design. Thrust blocking shall be provided on all piping three (3) inch diameter and larger.

2.8 DRIP IRRIGATION

A. Drip irrigation equipment shall be as specified on plans (emitter types, emitter flow rates, etc).

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Trenches for pipe sprinkler lines shall be excavated of sufficient depth and width to permit proper handling and installation by any other method the Contractor may desire if approved by the Owner, pipe manufacturer, and Designer. The backfill shall be thoroughly compacted and evened off with the adjacent soil level. Selected fill dirt or sand shall be used if soil conditions are rocky. In rocky areas the trenching depth shall be two (2) inches below normal trenching depth to allow for this bedding. The fill dirt or sand shall be used in filling (4) inches above the pipe. The remainder of the backfill shall contain

no lumps or rocks larger than three (3) inches. The top twelve (12) inches of backfill shall be topsoil, free of rocks, subsoil, or trash. Any open trenches or partially backfilled trenches left overnight or left unsupervised shall be barricaded to prevent undue hazard to the public.

B. The Contractor shall backfill in six (6) inch compacted lifts as needed to bring the soil to its original density.

C. In the spring following the year of installation, the Contractor shall repair any settlement of the trenches by bringing them to grade with topsoil, and seeding with the existing lawn type(s). Watering and maintenance of the repaired areas shall be the Owner's responsibility.

3.2 INSTALLATION OF PLASTIC PIPE

A. Plastic pipe shall be installed in a manner that permits expansion and contraction as recommended by the manufacturer.

B. Plastic pipe shall be cut with a handsaw or hacksaw with the assistance of a square in sawing vice or in a manner so as to ensure a square cut. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow will be obtained.

C. All plastic-to-plastic joints shall be solvent weld joints or slip seal joints. Only the solvent recommended for the pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer. The Contractor shall assume full responsibility for the correct installation.

D. The joints shall be allowed to set at least twenty-four (24) hours before pressure is applied to the system on PVC pipe.

3.3 CONTROLLER AND ELECTRICAL CONNECTIONS

A. All electrical connections shall conform to the National Electrical Code, latest edition.

B. Control wires installed beneath walks, drives, or other permanent surfaces shall be placed in sleeves.

C. Wires shall be spliced only at valve boxes.

D. Leave twenty-four (24) inch loop of wire at each valve for expansion/contraction and servicing.

E. Controllers and valves shall be from the same company e.g. (Rain Bird, Toro or approved equal).

F. 120 VAC electrical power supply to the controller location shall be supplied by others.

3.4 FLUSHING AND TESTING

A. After all new sprinkler piping and risers are in place and connected for a given section and all necessary division work has been completed and prior to the installation of sprinkler heads all control valves shall be opened and a full head of water used to flush out the system.

B. Sprinkler main shall be pressure tested as follows:

1. Two (2) hour pressure test at 1.5 times the system operating pressure
2. Twenty four (24) hour pressure test at the system operating pressure

3. If leaks occur, repair and repeat the test until no leaks occur (pressure does not drop). Give Designer twenty-four hours notice prior to testing.

C. Testing of the system shall be performed after completion of the entire installation and any necessary repairs shall be made at the Contractor's expense to put the system in good working order before final payment by the Owner.

D. Adjustment of the sprinkler heads, and automatic equipment, will be done by the Contractor upon completion of installation to provide optimum performance. Minor adjustments during the guarantee period will be made by the Owner.

E. After completion, testing, and acceptance of the system, the Contractor will instruct the Owner's personnel in the operation and maintenance of the system.

3.5 CLEAN UP AND PROTECTION

A. During irrigation work, Contractor shall keep project site clean and orderly

B. Upon Completion of Work, clear grounds of debris, superfluous materials and all equipment. Remove from site to satisfaction of the Owner's Representative.

3.6 WINTERIZING THE SYSTEM

A. Contractor's responsibility to winterize the irrigation system the first winter following Substantial Completion of the Project.

3.7 INSPECTION

A. Periodic Inspections will be made by the Landscape Architect/Owner's Representative to review the quality and progress of the work. Work found to be unacceptable must be corrected within a timely mater (to be determined by Owner's Representative). Remove rejected materials promptly from the project site.

B. It will be the responsibility of the Irrigation Contractor to provide a reliable communication system (i.e. Two way radios or remote radio control activation system) for Substantial Completion and all periodic inspections.

PART 4 - CODES, PERMITS, WARRANTY, AND GUARANTEE

4.1 CODES AND ORDINANCES

A. All materials, installation parameters, and operations shall conform to all applicable codes and ordinances. It is the Contractor's responsibility to investigate and follow all regulations. Contractor is responsible to verify applicable codes and ordinances prior to submitting bid. Before bid submittal, it is the Contractor's responsibility to notify the Irrigation Consultant/Designer at least 5 days before bid submittal, of any changes due to code or ordinance discrepancies. If the Contractor does not comply with this process and notification, the Contractor shall be responsible for the necessary installation change and redesign costs for non-compliance.

4.2 PERMITS AND FEES

A. The Contractor shall obtain, at his expense, all required permits and shall pay all required fees. Any penalties imposed due to failure to obtain any permit or pay any fee shall be the responsibility of the Contractor.

4.3 WARRANTY AND GUARANTEE

A. The Contractor shall furnish a certificate of warranty registration and a written guarantee of work and materials for a one year period from the date of final acceptance of the Irrigation System by the Owner and the Designer.

END OF SECTION 328400

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding: See Plans for limits of seeding.
2. Sodding: See Plans for limits of sodding.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of grass seed.

1. Certification of each seed mixture for turfgrass sod.
2. Certification of each seed mixture for turfgrass seed.

C. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.4 QUALITY ASSURANCE

A. Installer: A North Carolina Registered Landscape Contractor which has at least five (5) years experience in work of the size and type required by this section and which is acceptable to the Landscape Architect and Owner’s Representative.

B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

C. Topsoil Analysis: Contractor to furnish soil analysis by a qualified soil-testing laboratory.

1. Report suitability of topsoil for lawn growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.6 MAINTENANCE SERVICE

A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established or until final building acceptance by Owner, whichever is later.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species, as follows: Per Plans.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Per Plans

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m.

B. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

2.7 MULCHES

A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

1. Include nonasphaltic tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PLANTING SOIL MIX

A. Planting Soil Mix: Topsoil mixed with the soil amendments and fertilizers in the quantities per the results of the topsoil analysis.

PART 3 - EXECUTION

3.1 LAWN PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread planting soil mix to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Reduce elevation of planting soil to allow for soil thickness of sod.

B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
3. Removes stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner’s property.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

A. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

3.3 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than 300 lb/acre. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:3 with or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 LAWN MAINTENANCE

A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations until acceptable lawn is established or until final building acceptance by Owner, whichever is later. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.

B. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

3.6 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches, with at least 85% of the total grass coverage consisting of the specified grass species.

B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

C. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

END OF SECTION 329200

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Trees.
2. Shrubs.
3. Ground cover.
4. Annuals, Perennials, and Vines.
5. Planting Topsoil

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

E. Root Flare: Also called “trunk flare.” The area at the base of the plant’s stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

F. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

G. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

A. Submit all product submittals twelve (12) weeks prior to delivery and installation of plantings, including any plant substitutions.

B. Product Data: For each type of product indicated.

C. Affidavit: From nursery certifying that furnished trees meet the requirements specified under Section 2.1.

D. Plant sources: Provide the following for each submitted source:

1. Nursery name and location
2. List of the plants to be provided from the source. The plant list shall include the botanical and common name and the size at the time of selection.
3. Photographs of representative sample of each plant. Photographs shall be legible and contain a height reference, such as a measuring stick.

E. Planting Schedule: Indicating anticipated planting dates for each type of planting.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year.

G. Plant Substitutions for plants not available:

1. Submit all request for substitutions of plant species, or size to the Owner's Representative, for approval, prior to purchasing the proposed substitution.
2. Provide documentation of the plant suppliers contacted to substantiate unavailability.
3. Request for substitutions shall conform to all requirements described in Part 1.4.D of this specification.
4. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.
5. Request shall also include whether the substitution is of equal value, additional cost or amount of credit.

H. Soil Analysis: Conforming with requirements described in Part 1.4.C

1.4 QUALITY ASSURANCE

A. Installer: A North Carolina Registered Landscape Contractor which has at least five (5) years experience in work of the size and type required by this section and which is acceptable to the Landscape Architect and Owner's Representative.

1. References: Submit three letters of reference from owner's representatives for projects completed in the past 5 years of similar scope and dollar value, including names and phone numbers of contact person(s).

B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory.

1. Report suitability of topsoil for plant growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.

D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery and handling.

B. Handle planting stock by root ball.

C. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, store in a vertical position, protect from weather and mechanical damage, and keep roots moist.

D. Plants that are compromised or damaged during delivery, storage, and handling shall be replaced with healthy equivalent that meet or exceed the standards outlines in Part 2.

E. At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

F. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

G. Store bulbs, corns and tubers in a dry place at 60-65 degrees until planting.

1.6 WARRANTY

A. Special Warranty: Installer's standard form in which Installer agrees to repair or replace plantings that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, abuse by Owner, or incidents that are beyond Contractor's control.
   b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Final Acceptance by Owner:

   a. Trees and Shrubs: One year.
   b. Ground Cover, Perennials and Vines: One year.

1.7 MAINTENANCE SERVICE

A. Initial Maintenance Service for Plantings: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until Final Acceptance.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement. Furnish trees with the following characteristics:

1. Root System Development

   a. Trees shall have been nursery-grown in clay soil & irrigated with drip irrigation.
   b. Trunk flare shall be visible from the nursery.
   c. (100% mechanically root-pruned during the first three years of the trees' life).

2. Canopy Development

   a. Strong central leader to the top of the canopy. The tip of the leader on the main trunk must be intact and its terminal bud must be the highest part of the tree.

b. No branch shall have a diameter greater than 2/3 the trunk diameter measured directly above the branch crotch.
c. The tree crown must be structurally uniform. Branches shall be evenly distributed around the trunk. The crown shall be full of foliage which is evenly distributed around the tree.

3. Trunk

a. The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
b. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1.

C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form as indicated on Plant Schedule.

D. Shrub sizes indicated on Plant Schedule are sizes after pruning.

2.2 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.3 ANNUALS, PERENNIALS, AND VINES

A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, complying with requirements in ANSI Z60.1.

C. Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1.

2.4 TOPSOIL

A. General: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Material Content by Mass:

a. Sand Content: 20 to 60 percent
b. Silt and Clay Content: 35 to 70 percent
c. Deleterious materials (rock, gravel, slag, cinder, roots, sod): 5 percent max.

2. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

B. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Imported or manufactured topsoil subject to compliance with Topsoil requirements.

2.5 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with the soil amendments and fertilizers in the quantities per the results of the topsoil analysis in the soils report.

2.6 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.7 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m.

B. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.8 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.9 MULCHES

A. Organic Mulch: Fresh, long needle pine straw.

1. Color: natural

B. Pine Bark Mulch for Annual Beds: 3/8” fines

PART 3 - EXECUTION

3.1 PLANTING BED ESTABLISHMENT

A. Loosen subgrade of planting beds to a minimum depth of 24 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Following the tilling of the planting beds, spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.2 TREE AND SHRUB PLANTING

A. No planting shall take place during extremely hot, wet, or freezing weather.

B. No additional plants shall be distributed about the planting bed area than can be planted and watered on the same day.

C. Excavation of Pits and Trenches: Excavate circular pits with sides sloped inward. Trim and scarify base leaving center area raised slightly to support root ball and assist in drainage. Scarify sides of plant pit smeared or smoothed during excavation.

1. Excavate pits and trenches for trees at least 12 inches wider than root spread.

D. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

E. Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Backfill: Planting soil
2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.
4. Fabric Bag-Grown Stock: Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
5. Bare-Root Stock: Support stem of each plant and spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working. Carefully work backfill around roots by hand. Bring roots into close contact with the soil.
6. Continue backfilling process.

F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

G. Thoroughly water the Planting Soil and root ball immediately after planting.

H. Organic Mulching: Apply average thickness of organic mulch as indicated on planting details. Do not place mulch against trunks or stems as indicated on planting details.

3.3 TREE AND SHRUB PRUNING

A. Do not prune trees or shrubs before delivering to the site.

B. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Do not cut tree leaders; remove only injured or dead branches from flowering trees. Prune shrubs to retain natural character.

C. All pruning shall be performed by a person experienced in structural tree pruning.

D. Except for plants specified as multi-stemmed or as otherwise instructed by the Owner’s Representative, preserve or create a central leader.

E. Pruning of large trees shall be done using pole pruners or if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping, if approved by Landscape Architect.

F. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.

G. Pruning shall be done with clean, sharp tools.

H. No tree paint or sealants shall be used.

3.4 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants as indicated.

B. Schedule the planting to occur prior to application of the mulch. If the bed is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.

C. Dig holes large enough to allow spreading of roots and backfill with planting soil.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.5 PLANTING BED FINISHING

A. After planting, smooth out all grades between plants before mulching.

B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, one (1) and two (2) inches, than the adjacent turf sod or as direction by the Owner's Representative. Bed edge lines shall be depicted on the drawings.

3.6 PLANTING BED MULCHING

A. Mulch surfaces of planting beds and other areas indicated. Provide mulch ring around trees in lawn areas.

B. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

1. Organic Mulch: See planting details for average thickness of mulch. Do not place mulch against plant stems.

3.7 PLANT MAINTENANCE

A. Tree and Shrub Maintenance: Maintain plantings until Final Acceptance by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Ground Cover and Plant Maintenance: Maintain plantings until Final Acceptance by watering, weeding, fertilizing, mulching, and other operations as required to establish healthy, viable plantings.

C. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. At the time of Final Acceptance, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.8 CRITERIA FOR UNACCEPTABLE PLANTS

A. Criteria for rejection of plants will include but is not limited to:

1. Any dead or missing plant, any cause.
2. Defoliations of more than 25% of leaf area dead, lost or dropped for shrubs, vines or groundcovers.
3. Die back of more than 25% of the shrub height.
4. Bark wounds of more than 15% of bark circumference or 2” length for trees.
5. Die back, defoliation or wind burn of more than 10% of tree canopy.
6. Rootbound or circling roots, unless approved remediation by LA for contractor to cultivate roots using appropriate tools to loosen roots to promote healthy root establishment.

3.9 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in “Plant Maintenance” Article 3.6. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period for Trees and Shrubs: Twelve (12) months from date of Final Acceptance.
2. Maintenance Period for Ground Cover and Other Plants: Twelve (12) months from date of Final Acceptance.

END OF SECTION 329300