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DESTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Selective demolition of building elements for alteration purposes.
B. Legal disposal of demolished items.

1.02 RELATED REQUIREMENTS
A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
B. Section 01 10 00 - Summary: Sequencing and staging requirements.
C. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.

1.03 REFERENCE STANDARDS
A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE
A. Demolition Firm Qualifications: Company specializing in the type of work required.
   1. Minimum of 5 years of documented experience.

1.06 PROJECT CONDITIONS
A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE
A. As indicated on Drawings and herein specified.
   1. Remove other items indicated, for salvage and relocation.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS
A. Comply with other requirements specified in Section 01 70 00 Execution and Closeout Requirements.
B. Comply with applicable codes and regulations for demolition operations and safety of the public.
   1. Provide, erect, and maintain temporary dust proof partitions/wall assembly barriers and security devices.
   2. Use adequate physical barriers and wall assemblies to prevent access to areas that could be hazardous to workers or the public.
   3. Conduct operations to minimize effects on and interference with adjacent construction and occupants.
   4. Do not close or obstruct means of egress corridors, roadways or sidewalks without permit.
   5. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
C. Do not begin removal until built elements to be salvaged or relocated have been removed.

D. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

E. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB’s, and mercury.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not close, shut off, or disrupt existing life safety systems that are in use without permission from the Owner.

D. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without permission from the Owner.

E. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as indicated.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Separate areas in which demolition is being conducted from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions and wall assemblies during demolition and construction.

C. Remove existing work as indicated and as required to accomplish new work.
   1. At areas of demolition and transition, remove materials and finishes including, but not limited to, rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings and notes.

D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
   2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
   3. Verify that abandoned services serve only abandoned facilities before removal.
   4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

E. Protect existing work to remain.
   1. Perform cutting to accomplish removal neatly and as specified for cutting new work.
   2. Repair adjacent construction and finishes damaged during removal work.
3. Patch as specified for patching new work.
4. Patch to match existing at areas of transition and demolition unless noted and/or scheduled otherwise.

END OF SECTION
SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Formed steel stud exterior wall framing.
   B. Exterior wall sheathing.

1.02  ADMINISTRATIVE REQUIREMENTS
   A. Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.03  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.

PART 2  PRODUCTS

2.01  MANUFACTURERS
   A. Metal Framing:
      1. CEMCO: www.cemcosteel.com/#sle.
      3. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Framing Connectors and Accessories:
      1. Same manufacturer as metal framing.

2.02  FRAMING SYSTEM
   A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
   B. Deliver to site in largest practical sections.

2.03  FRAMING MATERIALS
   A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
      1. Gage and Depth: As indicated on drawings.
   B. Framing Connectors: Factory-made, formed steel sheet.
      1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gage, 0.1345 inch, and factory punched holes and slots.
      2. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
      3. Fixed Connections: Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

2.04  FASTENERS
   A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
B. Anchorage Devices: Powder actuated.

2.05 WALL SHEATHING
A. Glass mat faced gypsum board; ASTM C1177/C1177M, square long edges, 1/2 inch thick.

2.06 ACCESSORIES
A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that substrate surfaces are ready to receive work.
B. Verify field measurements and adjust installation as required.

3.02 INSTALLATION OF STUDS
A. Install components in accordance with manufacturers’ instructions and ASTM C1007 requirements.
B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
C. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
D. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
E. Install intermediate studs above and below openings to align with wall stud spacing.
F. Attach cross studs to studs for attachment of fixtures anchored to walls.
G. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

3.03 INSTALLATION OF WALL SHEATHING
A. Install wall sheathing with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
  1. Provide steel diagonal bracing at corners with foam insulation or gypsum board wall sheathing.

END OF SECTION
SECTION 05 43 00
SLOTTED CHANNEL (UNISTRUT) FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Slotted channel steel framing and supports shown as “Unistrut” on the drawings.

1.02 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for metal fabrications.
   1. Include plans, elevations, sections, and details of metal fabrications and their connections.
   2. Show anchorage and accessory items.
   3. Provide templates for anchors and bolts specified for installation under other Sections.

B. Pertinent manufacturers published data.

1.03 QUALITY ASSURANCE

A. Manufacturer: Firm regularly engaged in the manufacture of bolted metal framing of the types required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Bolted framing channels and fittings shall have the manufacturer’s name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

C. Work shall meet the requirements of the following standards:
   1. Federal, State and Local codes
   2. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members 2001 Edition
   3. American Society for Testing And Materials (ASTM)
   4. Metal Framing Manufacturer’s Association (MFMA)

1.04 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All material is to be delivered to the work site in original factory packaging to avoid damage to the finish.

B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

PART 2 PRODUCTS

2.01 “UNISTRUT"

A. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
   2. Material: Steel complying with ASTM A 1008/A 1008M, commercial steel, Type B; 0.0677-inch minimum thickness.
   3. Finishes:

2.02 FASTENERS

A. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
B. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.


2.03 FABRICATION, GENERAL

A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

C. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.04 FINISHES

A. No finishes required. Plain unistrut.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

C. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

D. Install strut in accordance with MFMA-102 ‘Guidelines for the Use of Metal Framing’; in accordance with equipment manufacturer's recommendations, and with recognized industry practices

E. Upon completion of this section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

3.02 ADJUSTING AND CLEANING

A. Clean field welds, bolted connections, and abraded areas.

B. Upon completion of this section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

END OF SECTION
SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Batt insulation in exterior wall construction.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

PART 2 PRODUCTS

2.01 APPLICATIONS
   A. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.02 BATT INSULATION MATERIALS
   A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.
   B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
      1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
   C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
      1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

2.03 ACCESSORIES
   A. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
   B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BATT INSTALLATION
   A. Install insulation in accordance with manufacturer's instructions.
   B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
   C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
   D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.03 PROTECTION
   A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
SECTION 07 21 19
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Foamed-in-place insulation.
   1. In masonry cavity walls.
   2. In exterior framed walls.
   3. In exterior wall crevices.
   4. At junctions of dissimilar wall and roof materials.

1.02 RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 78 39 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS

1.04 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.05 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
C. Certificates: Certify that products of this section meet or exceed specified requirements.
D. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience.

1.07 MOCK-UP
A. Locate where directed.
B. Mock-up may remain as part of the Work.

1.08 FIELD CONDITIONS
A. Do not install insulation when ambient temperature is lower than 70 degrees F.
B. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
C. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Foamed-In-Place Insulation:

2.02 MATERIALS
A. Foamed-In-Place Insulation: Medium-density, rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
   1. Aged Thermal Resistance: R-value of 6.7 (deg F hr sq ft)/Btu, minimum, when tested at 1 inch thickness in accordance with ASTM C518 after aging for 180 days at 41 degrees F.
   2. Water Vapor Permeance: Vapor retarder; 2 perm, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
   3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
   4. Air Permeance: 0.004 cfm/sq ft, maximum, when tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.5 psf.
   5. Closed Cell Content: At least 90 percent.
   6. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
   7. Products:

2.03 ACCESSORIES
A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify work within construction spaces or crevices is complete prior to insulation application.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION
A. Mask and protect adjacent surfaces from over spray or dusting.
B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION
A. Apply insulation in accordance with manufacturer's instructions.
B. Apply insulation by spray method, to a uniform monolithic density without voids. See drawings for thickness.
C. Shave insulation to face of metal framing as necessary.
D. Apply overcoat monolithically, without voids to fully cover foam insulation.
E. Patch damaged areas.
F. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Manufactured metal panels for exterior wall panels, interior liner panels, soffit panels, and subgirt framing assembly, with insulation, related flashings, and accessory components.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.03  DELIVERY, STORAGE, AND HANDLING
   A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
   B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
   C. Prevent contact with materials that may cause discoloration or staining of products.

1.04  WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2  PRODUCTS
2.01  MANUFACTURERS
   A. Metal Wall Panels - Concealed Fasteners:
      2. Substitutions:  See Section 01 60 00 - Product Requirements.

2.02  MANUFACTURED METAL PANELS
   A. Wall Panel System:  Factory fabricated prefinished metal panel system, site assembled.
      1. Provide exterior wall panels.
      2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
      4. Movement:  Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
      5. Drainage:  Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
      6. Fabrication:  Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
      7. Corners:  Factory-fabricated in one continuous piece with minimum 2 inch returns.

   B. Exterior Wall Panels:
      1. Profile:  Horizontal; style as indicated.
      2. Side Seams:  Double-interlocked, tight-fitting, sealed with continuous gaskets.
      3. Panel Width:  12 inches.
      4. Color:  As selected by Architect from manufacturer's full line.

   C. Subgirt Framing Assembly:
      1. Profile as indicated; to attach panel system to building.

   D. Expansion Joints:  Same material, thickness and finish as exterior sheets; ___ gage, ____ inch thick; manufacturer's standard brake formed type, of profile to suit system.

   E. Trim:  Same material, thickness and finish as exterior sheets; brake formed to required profiles.
F. Anchors: Galvanized steel.

2.03 MATERIALS
A. Precoated Aluminum Sheet: ASTM B209 (ASTM B209M), 3105 alloy, O temper, smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES
A. Exposed Surface Finish: Panel manufacturer’s standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.

2.05 ACCESSORIES
A. Gaskets: Manufacturer’s standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
B. Concealed Sealants: Non-curing butyl sealant or tape sealant.
C. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
D. Fasteners: Manufacturer’s standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.
E. Field Touch-up Paint: As recommended by panel manufacturer.
F. Bituminous Paint: Asphalt base.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that building framing members are ready to receive panels.

3.02 PREPARATION
A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.03 INSTALLATION
A. Install panels on walls in accordance with manufacturer’s instructions.
B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.
C. Fasten panels to structural supports; aligned, level, and plumb.

3.04 TOLERANCES
A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.05 CLEANING
A. Remove protective material from wall panel surfaces.
B. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

END OF SECTION
SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Firestopping systems.

1.02 REFERENCE STANDARDS
D. ITS (DIR) - Directory of Listed Products.
E. FM (AG) - FM Approval Guide.
G. UL (DIR) - Online Certifications Directory.
H. UL (FRD) - Fire Resistance Directory.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

1.04 QUALITY ASSURANCE
A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.

PART 2 PRODUCTS

2.01 MATERIALS
A. Firestopping Materials: Any materials meeting requirements.
B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS
A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
B. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
C. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

PART 3 EXECUTION

3.01 PREPARATION
A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
B. Remove incompatible materials that could adversely affect bond.

3.02 INSTALLATION
   A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.03 CLEANING
   A. Clean adjacent surfaces of firestopping materials.

3.04 PROTECTION
   A. Protect adjacent surfaces from damage by material installation.

END OF SECTION
SECTION 07 90 05
JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Sealants and joint backer rods.
B. Precompressed foam sealers.

1.02 REFERENCE STANDARDS

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordinate the work with other sections referencing this section.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
C. Samples: Submit two samples, 2 x 1/2 in size illustrating sealant colors for selection.
D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.
B. Applicator Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

1.06 FIELD CONDITIONS
A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 COORDINATION
A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective work within a five year period after Date of Substantial Completion.
C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Polyurethane Sealants:
2.02 SEALANTS

A. Sealants and Primers - General: Provide products having volatile organic compound (VOC) content as specified in Section 01 61 16.

B. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.
   2. Applications: Use for:
      a. Joints between concrete and other materials.
      b. Joints between metal frames and other materials.
      c. Other exterior joints for which no other sealant is indicated.

C. Type 2 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
   3. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
      c. Other interior joints for which no other type of sealant is indicated.

D. Type 3 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
   2. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
      c. Other interior joints for which no other type of sealant is indicated.

2.03 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that substrate surfaces and joint openings are ready to receive work.
B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION
A. Remove loose materials and foreign matter that could impair adhesion of sealant.
B. Clean and prime joints in accordance with manufacturer's instructions.
C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION
A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
B. Perform installation in accordance with ASTM C1193.
C. Perform acoustical sealant application work in accordance with ASTM C919.
D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
E. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
   2. Neck dimension no greater than 1/3 of the joint width.
   3. Surface bond area on each side not less than 75 percent of joint width.
F. Install bond breaker where joint backing is not used.
G. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
I. Tool joints concave.
J. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING
A. Clean adjacent soiled surfaces.

3.05 PROTECTION
A. Protect sealants until cured.

END OF SECTION
SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Gypsum wallboard.
B. Joint treatment and accessories.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on gypsum board, accessories, and joint finishing system.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES
A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.02 BOARD MATERIALS
A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Thickness:
      a. Vertical Surfaces: 1/2 inch.

2.03 ACCESSORIES
A. Beads, Joint Accessories, and Other Trim: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
   1. Rigid Corner Beads: Low profile, for 90 degree outside corners.
B. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
C. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
D. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that project conditions are appropriate for work of this section to commence.

3.02 BOARD INSTALLATION
A. Comply with ASTM C840, GA-216, and manufacturer’s instructions. Install to minimize butt end joints, especially in highly visible locations.
B. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
C. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.

3.03 INSTALLATION OF TRIM AND ACCESSORIES
A. Corner Beads: Install at external corners, using longest practical lengths.
3.04 JOINT TREATMENT
   A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
      1. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the
         completed construction.
   B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to
      receive finishes.
      1. Feather coats of joint compound so that camber is maximum 1/32 inch.

3.05 TOLERANCES
   A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet
      in any direction.

END OF SECTION
SECTION 09 65 00
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Resilient tile flooring.
B. Static control resilient tile flooring.
C. Resilient base.
D. Installation accessories.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
D. Sustainable Design Submittal: Submit VOC content documentation for flooring and adhesives.
E. Concrete Sub-floor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Flooring Material: 10 square feet of each type and color.
   3. Extra Wall Base: 2 linear feet of each type and color.

1.03 DELIVERY, STORAGE, AND HANDLING
A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
B. Store all materials off of the floor in an acclimatized, weather-tight space.
C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

1.04 FIELD CONDITIONS
A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 TILE FLOORING
A. Static Control Tile: Homogeneous; color and pattern throughout thickness.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Electrical Resistance:
      a. Dissipative Tile: Resistance between 1.0 megohms and 1000 megohms as tested in accordance with ASTM F150.
   3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
   4. Tile Size: 12 by 12 inch.
   5. Total Thickness: 0.125 inch.
6. Color: To be selected by Architect from manufacturer's full range.

2.02 RESILIENT BASE
A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Height: 4 inch.
   3. Thickness: 0.125 inch.
   5. Color: To be selected by Architect from manufacturer's full range.
   6. Accessories: Premolded external corners and internal corners.

2.03 ACCESSORIES
A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
C. Adhesive for Vinyl Flooring:
   1. Manufacturers:
D. Copper Grounding Strips: Type and size as recommended by static control flooring manufacturer.
E. Floor Polish for Static Control Flooring: Fluid-applied polish, intended to protect electrical properties of flooring, as recommended by static control flooring manufacturer.
F. Filler for Coved Base: Plastic.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
   1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION
A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
C. Prohibit traffic until filler is fully cured.
D. Clean substrate.

3.03 INSTALLATION - GENERAL
A. Starting installation constitutes acceptance of sub-floor conditions.
B. Install in accordance with manufacturer’s written instructions.
C. Spread only enough adhesive to permit installation of materials before initial set.
D. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 26 05 26 for grounding and bonding to building grounding system.

E. Fit joints and butt seams tightly.

F. Set flooring in place, press with heavy roller to attain full adhesion.

G. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

H. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

I. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

C. Install square tile to ashlar pattern. Allow minimum 1/2 full size tile width at room or area perimeter.

3.05 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.06 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

3.07 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION
SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints.
C. Scope: Finish all interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
   1. Mechanical and Electrical:
      a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
      b. In finished areas, paint shop-primed items.
D. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, terne, and lead items.
   6. Floors, unless specifically so indicated.
   7. Glass.
   8. Acoustical materials, unless specifically so indicated.
   9. Concealed pipes, ducts, and conduits.
E. Painting materials and methods for conduit identification specified in Section 26 05 53.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS

C. NACE (IMP) - Industrial Maintenance Painting; NACE International; Edition date unknown.
D. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings.

1.04 DEFINITIONS

A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on all finishing products and special coatings, including VOC content.
C. Samples: Submit two paper chip samples, 1 X 1 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
D. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on aluminum sheet, 6 x 6 inch in size.

E. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.

F. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.

G. Manufacturer's Instructions: Indicate special surface preparation procedures.

H. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 5 years documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience.

1.07 REGULATORY REQUIREMENTS
A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.08 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS
A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.10 EXTRA MATERIALS
A. See Section 01 60 00 - Product Requirements, for additional provisions.

B. Supply 1 gallon of each color; store where directed.

C. Label each container with color, type, texture, and room locations in addition to the manufacturer's label.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
B. Paints:
   1. ICI Paints North America: www.icipaints.com

C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
   1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
   3. Supply each coating material in quantity required to complete entire project's work from a single production run.
   4. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

B. Primers: As follows unless other primer is required or recommended by manufacturer of top coats; where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

C. Volatile Organic Compound (VOC) Content: Comply with Section 01 61 16.

D. Chemical Content: The following compounds are prohibited:
   1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di (2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

E. Colors: As indicated on drawings
   1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.03 PAINT SYSTEMS - INTERIOR

A. Paint I-OP - All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated:
   Including gypsum board, concrete, and door frames.
   1. Two top coats and one coat primer.
   2. Primer(s): As recommended by manufacturer of top coats.

2.04 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.

3.02 PREPARATION
A. Clean surfaces thoroughly and correct defects prior to coating application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.

E. Marks: Seal with shellac or stain blocker those which may bleed through surface finishes.

F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

3.03 APPLICATION
A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

B. Apply products in accordance with manufacturer's instructions.

C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

E. Apply each coat to uniform appearance.

F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

G. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT
A. Refer to Section 22 05 53, Section 23 05 53 and Section 26 05 53 for schedule of color coding of equipment, duct work, piping, and conduit.

B. Paint shop-primed equipment, where indicated.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Finish equipment, piping, conduit, and exposed duct work in utility areas in colors according to the color coding scheme indicated.
E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.

3.06 CLEANING
A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.07 PROTECTION
A. Protect finished coatings until completion of project.
B. Touch-up damaged coatings after Substantial Completion.

3.08 SCHEDULE - SURFACES TO BE FINISHED
A. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted.
   2. Fire rating labels, equipment serial number and capacity labels.
   3. Stainless steel items.
B. Paint the surfaces described below under Schedule - Paint Systems.
C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
   1. Paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment occurring in finished areas to match background surfaces, unless otherwise indicated.
   2. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.
   3. Paint shop-primed items occurring in finished areas.
   4. Paint interior surfaces of air ducts and convectors and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
   5. Paint dampers exposed behind louvers, grilles, and convectors and baseboard cabinets to match face panels.

3.09 SCHEDULE - COLORS
A. See Plans.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fire extinguishers.
B. Fire extinguisher cabinets.
C. Accessories.

1.02 REFERENCE STANDARDS
B. NFPA 10 - Standard for Portable Fire Extinguishers.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product data for fire extinguishers and cabinets.
C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
D. Manufacturer’s Installation Instructions: Indicate special criteria and wall opening coordination requirements.
E. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Fire Extinguishers, Cabinets and Accessories:

2.02 FIRE EXTINGUISHERS
A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   2. Temperature range:Minus 40 degrees F to 120 degrees F.
C. Carbon Dioxide Type Fire Extinguishers: Aluminum tank, with pressure gauge.
   1. Class: B:C type.
   2. Temperature range: Minus 40 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS
A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
B. Fire Rated Cabinet Construction: One-hour fire rated.
C. Cabinet Configuration: Semi-recessed type.
   1. Size to accommodate fire extinguisher and accessories.
   2. Trim: Projected trim, with ± 1 inch wide face.
D. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
E. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
F. Finish of Cabinet Exterior Trim and Door: No. 4 - Brushed stainless steel.
G. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES
   A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install cabinets plumb, level and secure in wall openings.
   C. Place extinguishers in cabinets.

3.03 SCHEDULES
   A. Lab 221:
      1. One Multi-Purpose Dry Chemical Extinguisher: 2A-10B:C.
      2. One Carbon Dioxide Extinguisher: 10B:C.

END OF SECTION
SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 REQUIREMENTS
   A. The fire protection system shall be designed and installed in a complete system by a designer/contractor licensed in the State and the locality of the project. All design calculations, permits, drawing submissions, and other necessary documents shall be provided by and submitted by the contractor to the local authority having jurisdiction (AHJ). All materials, components, programming, and devices shall be provided and installed as required by code and the local AHJ.

1.02 SECTION INCLUDES
   A. Pipe, fittings, valves, storage tanks, and connections for sprinkler, standpipe and fire hose, and combination sprinkler and standpipe systems.

1.03 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 09 91 23 - Interior Painting: Preparation and painting of interior fire protection piping systems.
   D. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Piping identification.
   E. Section - Fire-Suppression Sprinkler Systems: Sprinkler systems design.
   F. Section - Fire-Suppression Standpipes: Standpipe design.

1.04 REFERENCE STANDARDS
   A. ASME A112.18.1 - Plumbing Supply Fittings.
   B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators.
   D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
   E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
   F. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.
   H. ASME B16.11 - Forged Fittings, Socket-welding and Threaded.
   I. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   J. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
   K. ASME B16.25 - Buttwelding Ends.
   L. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
X. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
AD. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
AE. AWS D1.1/D1.1M - Structural Welding Code - Steel.
AF. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
AH. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
AI. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
AJ. AWWA C606 - Grooved and Shouldered Joints.
AK. FM (AG) - FM Approval Guide.
AL. ITS (DIR) - Directory of Listed Products.
AN. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
AP. UL (DIR) - Online Certifications Directory.
AQ. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc..
AR. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc..

1.05 SUBMITTALS
B. Project Record Documents: Record actual locations of components and tag numbering.
C. Operation and Maintenance Data: Include installation instructions and spare parts lists.
1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Designer / Installer Qualifications: Company licensed and insured in the jurisdiction of installation, specializing in performing the work of this section with at least 5 years documented experience.

C. Conform to UL, UL (DIR), and ITS (DIR) or Warnock Hersey requirements.

D. Valves: Bear UL, UL (DIR), and ITS (DIR) or Warnock Hersey product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.08 EXTRA MATERIALS

A. Provide two valve stem packings for each size and type of valve installed.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEMS


B. Standpipe and Hose Systems: Conform to NFPA 14.

C. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 BURIED PIPING


1. Steel Fittings: ASME B16.9, wrought steel, butt welded, ASME B16.25, butt weld ends, ASTM A234/A234M, wrought carbon steel or alloy steel, ASME B16.5, steel flanges and fittings, or ASME B16.11, forged steel socket welded and threaded; with double layer, half-lapped polyethylene tape.


3. Joints: Welded in accordance with AWS D1.1/D1.1M.

4. Casing: Closed glass cell insulation.

B. Copper Tube: ASTM B75/B75M or ASTM B88 (ASTM B88M), O60 or O50 temper.

1. Type: Type K (A).

2. Fittings: ASME B16.18, cast copper alloy, solder joint, pressure type.

3. Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 copper/silver braze.

4. Casing: Closed glass cell insulation.


2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket.

2.03 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53 Schedule 40, black.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), H58 drawn.
   1. Fittings: ASME B16.18, cast copper alloy, grooved.
   2. Mechanical Grooved Couplings: Ductile iron housing with alkyd enamel paint coating clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers.

C. CPVC Pipe: ASTM F442/F442M, SDR 13.5.
   1. Fittings: ASTM F438 Schedule 40, or ASTM F439 schedule 80, CPVC.

   2. Joints: AWWA C111/A21.11, SBR or vulcanized styrene butadiene rubber gasket.
   3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.04 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.

B. Pipe Passing Through Below Grade Exterior Walls:
   1. Zinc coated or cast iron pipe.
   2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

D. Not required for wall hydrants for fire department connections or in drywall construction.

E. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
   3. All Rated Openings: Caulked tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.

2.05 ESCUTCHEONS

A. Material:

B. Construction:
   1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
   2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.06 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
F. Vertical Support: Steel riser clamp.
G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.07 MECHANICAL COUPLINGS

A. Manufacturers:
   1. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Rigid Mechanical Couplings for Grooved Joints:
   3. Housing Material: Fabricate of ductile iron conforming to ASTM A536.
   5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
   6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.

   1. ProPress fittings 1/2-inch thru 4-inch for use with ASTM B88 copper tube type K, L, or M and 1/2-inch up to include 1-1/4-inch annealed copper tube. ProPress fittings shall have an EPDM sealing element and Smart Connect (SC) feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element and Smart Connect (SC) feature. UL listed for Fire Protection use.

2.08 VALVES:

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. GATE VALVES
   1. Up to and including 2 inches:
      a. Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.
   2. Over 2 inches:
a. Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged ends.

3. Over 4 inches:
   a. Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

C. GLOBE VALVES
   1. Up to and including 2 inches:
      a. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.
   2. Over 2 inches:
      a. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

D. BALL VALVES
   1. Up to and including 2 inches:
      a. Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends.
   2. Over 2 inches:
      a. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

E. BUTTERFLY VALVES
   1. Bronze Body:
      a. Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
   2. Cast or Ductile Iron Body
      a. Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and internal tamper switch rated 10 amp at 115 volt AC.

F. CHECK VALVES
   1. Up to and including 2 inches:
      a. Bronze body and swing disc, rubber seat, threaded ends.
   2. Over 2 inches:
      a. Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
   3. 4 inches and Over:
      a. Iron body, bronze disc, stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

G. DRAIN VALVES
   1. Compression Stop:
      a. Bronze with hose thread nipple and cap.
   2. Ball Valve:

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and foreign material, from inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.
3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Install standpipe piping, hangers, and supports in accordance with NFPA 14.

C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

D. Install piping to conserve building space, to not interfere with use of space and other work.

E. Group piping whenever practical at common elevations.

F. Sleeve pipes passing through partitions, walls, and floors.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

I. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   6. Provide copper plated hangers and supports for copper piping.
   7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Do not penetrate building structural members unless indicated.

M. Provide sleeves when penetrating footings, floors, walls, partitions, and _______. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
   1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
   2. Aboveground Piping:
      a. Pack solid using mineral fiber conforming to ASTM C592.
      b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
3. All Rated Openings: Caulk tight with fire stopping material conforming to ASTM E814 in accordance with Section 07 84 00 to prevent the spread of fire, smoke, and gases.
4. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

N. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

O. Escutcheons:
1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

P. Storage Tank:
1. Testing
   a. Tank shall be tested according to the manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.
2. 3.2 Installation
   a. Tank shall be installed according to the manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.
   b. Contractor shall be trained by the tank manufacturer, the state or other approved agency.

Q. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

R. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

S. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.

T. Provide gate, ball, or butterfly valves for shut-off or isolating service.

U. Provide drain valves at main shut-off valves, low points of piping and apparatus.

3.03 CLEANING
A. Upon completion of work, clean all parts of the installation.
B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION
SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPP. PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe markers.
   E. Ceiling tacks.

1.02 RELATED REQUIREMENTS
   A. Section 09 91 23 - Interior Painting: Stencil paint.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   C. Product Data: Provide manufacturers catalog literature for each product required.
   D. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.
   E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved letters.
      2. Letter Height: 1/4 inch.

2.03 TAGS
   A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
   B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
   C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 STENCILS
   A. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.


2.05 PIPE MARKERS
B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.06 CEILING TACKS
A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION
3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.02 INSTALLATION
A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.
C. Apply stencil painting in accordance with Section 09 91 23.
D. Install plastic pipe markers in accordance with manufacturer's instructions.
E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
G. Identify pumps and valves with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
H. Identify control panels and major control components outside panels with plastic nameplates.
I. Identify thermostats relating to terminal boxes or valves with nameplates.
J. Identify valves in main and branch piping with tags.
K. Tag automatic controls, instruments, and relays. Key to control schematic.
L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 21 07 19
FIRE SUPPRESSION PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Piping insulation.
B. Jackets and accessories.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.

1.03 REFERENCE STANDARDS
L. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS
2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER
A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

B. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 650 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.03 CELLULAR GLASS
A. Insulation: ASTM C552, Type II.
   1. Apparent Thermal Conductivity; 'K' Value: Grade 6, 0.35 at 100 degrees F.
   2. Service Temperature: Up to 800 degrees F.
   3. Water Vapor Permeability: 0.005 perm inch.
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 EXPANDED POLYSTYRENE
A. Insulation: ASTM C578; rigid closed cell.
   1. 'K' Value: 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 165 degrees F.
3. Maximum Water Vapor Permeance: 5.0 perms.

2.05 HYDROUS CALCIUM SILICATE
A. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
   1. 'K' Value: ASTM C177 and ASTM C518; 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1200 degrees F.
B. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
C. Insulating Cement: ASTM C449.

2.06 FLEXIBLE ELASTOMERIC CELLULAR INSULATION
A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.07 JACKETS
A. PVC Plastic.
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.
   2. Covering Adhesive Mastic: Compatible with insulation.
   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

G. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

I. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

J. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE
A. Piping Exposed to Freezing with Heat Tracing (Exterior, Garage Areas, Loading Dock Areas):
1. Insulation Material: Mineral fiber
   a. Insulation Thickness: Apply the following insulation thicknesses:
      1) Pipe, Any pipe size: 2.0 inch.
   c. Vapor Retarder Required: No.
   d. Finish: None.

END OF SECTION
SECTION 21 13 00
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Wet-pipe sprinkler system.
   B. Deluge sprinkler system.
   C. System design, installation, and certification.
   D. Fire department connections.

1.02 RELATED REQUIREMENTS
   A. Section 28 46 00 - Fire Detection and Alarm.
   B. Section 21 05 00 - Common Work Results for Fire Suppression: Pipe and fittings.
   C. Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
   D. Section 21 05 53 - Identification for Fire Supp. Piping and Equipment.
   E. Section 21 30 00 - Fire Pumps.
   F. Section 21 12 00 - Fire-Suppression Standpipes.
   G. Section 14 91 00 - Facility Chutes: Sprinkler heads inside chutes.
   H. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   I. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
   J. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
   A. FM (AG) - FM Approval Guide.
   B. FM P7825 - Approval Guide; Factory Mutual Research Corporation.
   C. ITS (DIR) - Directory of Listed Products.
   F. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS
   A. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
   B. Shop Drawings:
      1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
      2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
      3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.
   C. Samples: Submit one of each style of sprinkler specified.
   D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

H. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.05 QUALITY ASSURANCE
A. Maintain one copy of referenced design and installation standard on site.
B. Conform to FM (AG) requirements.
C. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience approved by manufacturer.
F. Equipment and Components: Provide products that bear FM (AG) label or marking.
G. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 MOCK-UP
A. Provide components for installation in mock-up.
B. Mock-up may not remain as part of the Work.

1.07 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING
A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.09 EXTRA MATERIALS
A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
B. Provide suitable wrenches for each sprinkler type.
C. Provide metal storage cabinet located adjacent to alarm valve.

PART 2 PRODUCTS

2.01 SPRINKLER SYSTEM
A. Sprinkler System: Provide coverage for building areas noted.
B. Occupancy: Light hazard; comply with NFPA 13.
C. Water Supply: Determine volume and pressure from water flow test data.
   1. Revise design when test data available prior to submittals.
D. Interface system with building fire and smoke alarm system.
E. Provide fire department connections where indicated.
F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.02 SPRINKLERS
A. Suspended Ceiling Type: Recessed-type, chrome-plated with push on, clamp, or screw type escutcheon plates.
   1. Finish: Chrome plated.
      a. Within Standard Acoustical Tile Ceilings: White with White Estucheon Plate
      b. Within Wooden Finish Acoustical Clouds: Chrome Plated with Chrome Plated Estucheon Plate
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
B. Exposed Area Type: Standard upright type with guard.
   1. Finish: Chrome plated.
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
C. Sidewall Type: Standard, Semi-recessed or Recessed horizontal sidewall type with matching push on escutcheon plate and guard.
   1. Finish: Chrome plated.
   2. Escutcheon Plate Finish: Chrome plated.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
D. Dry Sprinklers: Standard, Recessed or Exposed pendant type with matching push on escutcheon plate.
   1. Finish: Chrome plated.
   2. Escutcheon Plate Finish: Chrome plated.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
E. Guards: Finish to match sprinkler finish.
F. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.

2.03 PIPING SPECIALTIES
A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.
B. Flooding Deluge Valve: Gate type valve with rubber faced disc actuated manually with water motor alarm and electric alarm, with alarm testing trim.
C. Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.
D. Test Connections:
   1. Backflow Preventer Test Connection:
      a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.
      b. Furnish one valve for each 250 gpm of system demand or fraction thereof.
      c. Provide permanent sign reading "Test Valve" in accordance with Section 22 05 53.
E. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.

2.04 PRESSURE MAINTENANCE PUMP
A. Type: Close coupled motor and positive displacement pump unit.
B. Construction: Bronze with stainless steel shafts, carbon bearings.
C. Motor: Open drip proof, permanently lubricated.
D. Electrical Characteristics:
   1. 0.33 hp.
   2. 115 volts, single phase, 60 Hz.
E. Accessories: Include flexible hose connections.
F. Operation: Manual or Automatic with pressure switch actuation.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with referenced NFPA design and installation standard.
B. Install equipment in accordance with manufacturer's instructions.
C. Place pipe runs to minimize obstruction to other work.
D. Place piping in concealed spaces above finished ceilings.
E. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
G. Install and connect to fire pump system in accordance with Section 21 30 00.
H. Flush entire piping system of foreign matter.
I. Install guards on sprinklers where indicated.
J. Hydrostatically test entire system.
K. Require test be witnessed by Fire Marshal.

3.02 INTERFACE WITH OTHER PRODUCTS
A. Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION
SECTION 22 10 06
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Drains.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS
   A. ASME A112.6.3 - Floor and Trench Drains.

1.04 SUBMITTALS
   A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
   B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
   C. Certificates: Certify that grease or oil interceptors meet or exceed specified requirements.
   D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
   E. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
   F. Operation Data: Indicate frequency of treatment required for interceptors.
   G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS
2.01 DRAINS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

   B. Floor Drain:
      1. Square, type 304 stainless steel adjustable floor drain with anchor flange and medium-duty vertically adjustable satin finish top.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
   C. Encase exterior cleanouts in concrete flush with grade.
   D. Install floor cleanouts at elevation to accommodate finished floor.
E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories, sinks, washing machines, toilets, urinal and any other quick closing valves.

END OF SECTION
SECTION 23 05 13
MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIP

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Single phase electric motors.
B. Three phase electric motors.

1.02 RELATED REQUIREMENTS
A. Section 26 72 26 - Wiring Devices: Electrical characteristics and Wiring Devices.
B. Section 26 29 13 - Enclosed Controllers.

1.03 REFERENCE STANDARDS
A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
C. NEMA MG 1 - Motors and Generators.
D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS
A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
D. Operation Data: Include instructions for safe operating procedures.
E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
B. Conform to applicable electrical code, NFPA 70 and local energy code.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY
A. Provide five year manufacturer warranty for motors larger than 20 horsepower.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lincoln Motors:  www.lincolnmotors.com/#sle.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service, General.  See drawings for specific details:
   1. Motors 1/2 HP and Smaller:  115 volts, single phase, 60 Hz
   2. Motors Larger than 1/2 Horsepower:  460 volts, three phase, 60 Hz.

B. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 40 degrees C environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class,
      service factor, and motor enclosure type.
   4. Motors with frame sizes 254T and larger:  Premium Efficiency Type.

C. Explosion-Proof Motors:  UL approved and labelled for hazard classification, with over
   temperature protection.

D. Visible Nameplate:  Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps,
   locked rotor amps, frame size, manufacturer's name and model number, service factor, power
   factor.

E. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials
      indicated.  Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit
      connection in end frame.

2.03 APPLICATIONS

A. Exception:  Motors less than 250 watts, for intermittent service may be the equipment
   manufacturer's standard and need not conform to these specifications.

B. Single phase motors for shaft mounted fans and centrifugal pumps:  Split phase type.

C. Single phase motors for shaft mounted fans or blowers:  Permanent split capacitor type or
   electronically commutated (ECM) type.  See schedules for requirements.

D. Single phase motors for fans, pumps, and blowers:  Capacitor start type.

E. Single phase motors for fans, blowers, and pumps:  Capacitor start, capacitor run type.

F. Motors located in outdoors and in draw through cooling towers:  Totally enclosed weatherproof
   epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque:  Less than 150 percent of full load torque.

B. Starting Current:  Up to seven times full load current.

C. Breakdown Torque:  Approximately 200 percent of full load torque.

D. Drip-proof Enclosure:  Class A (50 degrees C temperature rise) insulation, NEMA Service
   Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors:  Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor,
   prelubricated ball bearings.
2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.
B. Starting Current: Up to six times full load current.
C. Multiple Speed: Through tapped windings.
D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.
B. Starting Current: Less than five times full load current.
C. Pull-up Torque: Up to 350 percent of full load torque.
D. Breakdown Torque: Approximately 250 percent of full load torque.
E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.
B. Starting Current: Six times full load current.
C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
E. Insulation System: NEMA Class B or better.
F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13.
I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
J. Sound Power Levels: To NEMA MG 1.
K. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
M. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

N. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Provide detailed installation and purchase information for reimbursement by Utility for rebate program.

3.02 SCHEDULE - PREMIUM EFFICIENCY

A. NEMA Open Motor Service Factors.

1. 1/6-1/3 hp:
   a. 3600 rpm: 1.35.
   b. 1800 rpm: 1.35.
   c. 1200 rpm: 1.35.
   d. 900 rpm: 1.35.

2. 1/2 hp:
   a. 3600 rpm: 1.25.
   b. 1800 rpm: 1.25.
   c. 1200 rpm: 1.25.
   d. 900 rpm: 1.15.

3. 3/4 hp:
   a. 3600 rpm: 1.25.
   b. 1800 rpm: 1.25.
   c. 1200 rpm: 1.15.
   d. 900 rpm: 1.15.

4. 1 hp:
   a. 3600 rpm: 1.25.
   b. 1800 rpm: 1.15.
   c. 1200 rpm: 1.15.
   d. 900 rpm: 1.15.

5. 1.5-150 hp:
   a. 3600 rpm: 1.15.
   b. 1800 rpm: 1.15.
   c. 1200 rpm: 1.15.
   d. 900 rpm: 1.15.

B. Three Phase - Premium Efficiency, Open Drip-Proof Performance:

1. Ratings.
   a. 1 hp:
      1) NEMA Frame: 145T.
      2) Minimum Percent Power Factor: 72.
      3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM
   b. 1-1/2 hp:
      1) NEMA Frame: 182T.
      2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 86.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM

c. 2 hp:
   1) NEMA Frame: 184T.
   2) Minimum Percent Power Factor: 75.
   3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM

d. 3 hp:
   1) NEMA Frame: 213T.
   2) Minimum Percent Power Factor: 60.
   3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 89.5% @ 1800 RPM, 85.5% @ 3600 RPM

e. 5 hp:
   1) NEMA Frame: 215T.
   3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM

f. 7-1/2 hp:
   1) NEMA Frame: 254T.
   2) Minimum Percent Power Factor: 73.
   3) Minimum Percent Efficiency: 90.2% @ 1200 RPM, 91% @ 1800 RPM, 88.5% @ 3600 RPM

g. 10 hp:
   1) NEMA Frame: 256T.
   2) Minimum Percent Power Factor: 74.
   3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM

h. 15 hp:
   1) NEMA Frame: 284T.
   2) Minimum Percent Power Factor: 77.
   3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 90.2% @ 3600 RPM

i. 20 hp:
   1) NEMA Frame: 286T.
   2) Minimum Percent Power Factor: 78.
   3) Minimum Percent Efficiency: 92.4% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM

j. 25 hp:
   1) NEMA Frame: 324T.
   2) Minimum Percent Power Factor: 74.
   3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

k. 30 hp:
   1) NEMA Frame: 326T.
   2) Minimum Percent Power Factor: 78.
   3) Minimum Percent Efficiency: 93.6% @ 1200 RPM, 94.1% @ 1800 RPM, 91.7% @ 3600 RPM

l. 40 hp:
   1) NEMA Frame: 364T.
   2) Minimum Percent Power Factor: 77.
3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1 @ 1800 RPM, 92.4% @ 3600 RPM

m. 50 hp:
1) NEMA Frame: 365T.
2) Minimum Percent Power Factor: 79.
3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM

n. 60 hp:
1) NEMA Frame: 404T.
2) Minimum Percent Power Factor: 82.
3) Minimum Percent Efficiency: 93.

o. 75 hp:
1) NEMA Frame: 405T.
3) Minimum Percent Efficiency: 93.

p. 100 hp:
1) NEMA Frame: 444T.
3) Minimum Percent Efficiency: 93.

C. Three Phase - Premium Efficiency, Totally Enclosed, Fan Cooled Performance:
1. 1200 rpm.
a. 1 hp:
1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM

b. 1-1/2 hp:
1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM

c. 2 hp:
1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 68.
3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM

d. 3 hp:
1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 63.
3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM

e. 5 hp:
1) NEMA Frame: 215T.
3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 88.5% @ 3600 RPM

f. 7-1/2 hp:
1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 68.
3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM
g. 10 hp:
1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 75.
3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 90.2% @ 3600 RPM

h. 15 hp:
1) NEMA Frame: 284T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 92.4% @ 1800 RPM, 91% @ 3600 RPM

i. 20 hp:
1) NEMA Frame: 286T.
2) Minimum Percent Power Factor: 76.
3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM

j. 25 hp:
1) NEMA Frame: 324T.
3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

k. 30 hp:
1) NEMA Frame: 326T.
2) Minimum Percent Power Factor: 79.
3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

l. 40 hp:
1) NEMA Frame: 364T.
2) Minimum Percent Power Factor: 78.
3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1% @ 1800 RPM, 92.4% @ 3600 RPM

m. 50 hp:
1) NEMA Frame: 365T.
2) Minimum Percent Power Factor: 81.
3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM

n. Over 50 HP - Refer to National Grid "Motor Up" Energy Efficiency requirements for reimbursement.

END OF SECTION
SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Flexible pipe connectors.
   B. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.
   B. Section 23 22 13 - Steam and Condensate Heating Piping.
   C. Section 23 23 00 - Refrigerant Piping.

1.03 REFERENCE STANDARDS
   B. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS
   A. Product Data:
      1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
      2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
   B. Design Data: Indicate selection calculations.
   C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
   D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
   E. Maintenance Data: Include adjustment instructions.

1.05 REGULATORY REQUIREMENTS
   A. Conform to UL (DIR) requirements.

1.06 EXTRA MATERIALS
   A. Supply two sets of packing for each packed expansion joint.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
   A. Manufacturers:
   B. Inner Hose: Bronze.
   C. Exterior Sleeve: Single braided, stainless steel or bronze.
   D. Pressure Rating: 125 psi and 450 degrees F.
   E. Joint: Flanged.
   F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturer:
B. Inner Hose: Bronze.
C. Exterior Sleeve: Braided bronze.
D. Pressure Rating: 125 psi and 450 degrees F.
E. Joint: Flanged.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.
H. Application: Copper piping.

2.03 EXPANSION LOOPS

A. All expansion loops shall be piped as hard type.

2.04 ACCESSORIES

A. Stainless Steel Pipe: ASTM A269/A269M, seamless type, Grade TP304.
B. Pipe Alignment Guides:
   1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
C. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.
G. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.

END OF SECTION
SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Positive displacement meters.
   B. Flow meters.
   C. Pressure gauges and pressure gauge taps.
   D. Thermometers and thermometer wells.
   E. Static pressure gauges.
   F. Filter gauges.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.
   B. Section 23 09 23 - Direct-Digital Control System for HVAC.
   C. Section 23 09 93 - Sequence of Operations for HVAC Controls.

1.03 REFERENCE STANDARDS
   A. ASME B40.100 - Pressure Gauges and Gauge Attachments.
   E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case.
   F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service.
   G. AWWA C702 - Cold-Water Meters -- Compound Type.
   H. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold Water Meters; American Water Works Association (ANSI/AWWA C706).
   J. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
   K. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.04 SUBMITTALS
   A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
   B. Project Record Documents: Record actual locations of components and instrumentation.
   C. Operation and Maintenance Data: Manufacturer's Standards and Operations and maintenance manuals and catalog cuts.

1.05 FIELD CONDITIONS
   A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.06 EXTRA MATERIALS
   A. Supply two bottles of red gage oil for static pressure gages.
   B. Supply two pressure gages with pulsation damper or dial thermometers.
PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)

A. Manufacturers:
   4. Substitutions:  See Section 01 60 00 - Product Requirements.

B. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.

C. Meter:  Brass body turbine meter with magnetic drive register.
   1. Service:  Cold water, 122 degrees F.
   2. Service:  Hot water, 200 degrees F.
   3. Accuracy:  1-1/2 percent.
   4. Maximum Counter Reading:  10 million gallons.
   5. Size:  1/2 inch.

2.02 PRESSURE GAUGES

A. Manufacturers:
   1. Trerice:  www.trerice.com
   2. Wika USA:  www.wika.us

B. Pressure Gages:  ASME B40.100, UL 393 liquid filled, stainless steel bourdon tube, bronze movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case:  Steel with brass bourdon tube.
   2. Size:  8 inch dial diameter when installed higher than 8 feet above finished floor
   3. Size:  4-1/2 inch dial diameter when installed 8 feet or less above finished floor
   4. Mid-Scale Accuracy:  One percent.
   5. Scale:  Psi.
   6. Each gage connection shall have full port ball valve for isolation

2.03 PRESSURE GAUGE TAPPINGS

A. Ball Valve:  Full port ball valve

B. Pulsation Damper:  Pressure snubber, brass with 1/4 inch connections.

C. Syphon:  Steel, Schedule 40 or Brass, 1/4 inch angle or straight pattern.

2.04 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Trerice:  www.trerice.com
   2. Wika USA:  www.wika.us

B. Thermometers - Fixed 90 deg Angle:  Blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, and valox case.
   1. Size:  5.5 inch (139.7 mm) scale.
   2. Window:  Clear Acrylic.
   4. Accuracy:  2 percent, per ASTM E77.
   5. Calibration:  Degrees F and Degrees C.
   6. Trerice M/N HT31, range code 41 for chilled water and range code 47 for heating hot water.
2.05 THERMOMETER SUPPORTS
   A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
   B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS
   A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
   B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.07 STATIC PRESSURE GAUGES
   A. Manufacturers:
      2. 2-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
      C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
      D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION
3.01 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
   C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
   D. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
   E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
   F. Install thermometers in air duct systems on flanges.
   G. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
   H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
   I. Coil and conceal excess capillary on remote element instruments.
   J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
   K. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
L. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

M. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets or where indicated.

3.02 SCHEDULE

A. Pressure Gages, Location:
   1. Pumps.
   2. Expansion tanks.
   3. Pressure tanks.
   4. Standpipe, highest points.
   5. Standpipe and sprinkler water supply connection.
   6. Sprinkler system.
   7. Pressure reducing valves.
   8. Backflow preventers.

B. Pressure Gauge Tappings, Location:
   3. Heat exchangers - inlets and outlets.

C. Stem Type Thermometers, Location and Scale Range:
   1. Headers to central equipment.
   2. Coil banks - inlets and outlets.
   3. Heat exchangers - inlets and outlets.
   4. Water zone supply and return.
   5. After major coils.
   6. Domestic hot water supply and recirculation.

D. Thermometer Sockets, Location:
   1. Control valves 1 inch & larger - inlets and outlets.
   2. Reheat coils - inlets and outlets.
   3. Cabinet heaters - inlets and outlets.
   4. Unit heaters - inlets and outlets.

E. Static Pressure and Filter Gauges, Location and Scale Range:
   1. Built up filter banks.
   2. Unitary filter sections.
   4. Building static.

END OF SECTION
SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02  RELATED REQUIREMENTS

1.03  REFERENCE STANDARDS
D. MFMA-4 - Metal Framing Standards Publication.

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.05  QUALITY ASSURANCE
A. Comply with applicable building code.

PART 2  PRODUCTS

2.01  SUPPORT AND ATTACHMENT COMPONENTS
A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 2.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
D. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
F. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
G. Secure fasteners according to manufacturer's recommended torque settings.
H. Remove temporary supports.

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe markers.
E. Ceiling tacks.

1.02 RELATED REQUIREMENTS
A. Section 09 91 23 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

1.04 REQUIREMENTS
A. All piping, valves, ductwork, pumps, fans, terminal units, and equipment shown on drawings shall be labeled in field. Labels shall correlate to that shown on drawings.

1.05 SUBMITTALS
A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
C. Product Data: Provide manufacturers catalog literature for each product required.
D. Samples: Submit two labels or tags 1/2 x 4 inch in size.
E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
F. Project Record Documents: Record actual locations of tagged valves. Valve label schedule to include system, function and location. Once approved, schedule shall be retained in Owner's final project turnover documentation.
G. Equipment label schedule to include system, function, and location. once approved, schedule shall be retained in Owner's final project turnover documentation.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
A. Air Handling Units: Nameplates.
B. Air Terminal Units: Tags.
C. Automatic Controls: Tags. Key to control schematic.
D. Control Panels: Nameplates.
E. Instrumentation: Tags.
F. Piping: Pipe markers.
G. Pumps: Nameplates.
H. Tanks: Nameplates.
I. Thermostats: Nameplates.
J. Valves: Tags and ceiling tacks where located above lay-in ceiling.
K. Water Treatment Devices: Nameplates.
2.02 MANUFACTURERS

2.03 NAMEPLATES
   A. Description:  Laminated three-layer plastic with engraved letters.
      2. Letter Height:  1/2 inch.

2.04 TAGS
   A. Plastic Tags:  Laminated three-layer plastic with engraved black letters on white background color.
      Tag size minimum 1-1/2 inch diameter.
   B. Metal Tags:  Aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
   C. Valve Tag Chart:  Typewritten letter size list in anodized aluminum frame.  Valve tag chart is to include system, function, and location.

2.05 STENCILS
   A. Stencils:  With clean cut symbols and letters of following size:
      1. Ductwork and Equipment :  1 inch high letters
   B. Stencil Paint:  As specified in Section 09 91 23, semi-gloss enamel, colors conforming to ASME A13.1.

2.06 PIPE MARKERS
   A. Plastic Tape Pipe Markers:  Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.07 CEILING TACKS
   A. Description:  Steel with 3/4 inch diameter color coded head.
   B. Color code as follows:
      1. HVAC Equipment:  Yellow.
      2. Fire Dampers and Smoke Dampers:  Red.

PART 3 EXECUTION

3.01 PREPARATION
   A. Degrease and clean surfaces to receive adhesive for identification materials.
   B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.02 INSTALLATION
   A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive.  Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   B. Install tags with corrosion resistant chain.
   C. Apply stencil painting in accordance with Section 09 91 23.
   D. Install plastic pipe markers in accordance with manufacturer's instructions.
   E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to terminal boxes or valves with nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers or stencilled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with plastic nameplates or stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

N. Locate ceiling tacks to locate valves, units, or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

O. Identify piping, concealed or exposed, by color code listed below and with plastic pipe markers. Insulated systems may select jacketing to coincide w/color code. Identify service, and flow direction. Install in clear view and align with axis of piping.

P. Identify ductwork, (Supply Fan/Return Fan/Exhaust Fan) and direction of air flow with equipment labels or stenciled painting, identify with air handling unit identification number and area served.

Q. Install valve tags on all valves.

R. Install equipment name lates or stencil paint all equipment

S. Identify air handling units, pumps, fans, heat transfer equipment, tanks, air compressors, and water treatment devices with name plates or stencil painting.

T. Attache equipment tag to corner of removal ceiling tile grid facting into room for the following components:
   1. Fire dampers/smoke dampers
   2. Critical hydronic isolation and vent valves.
   3. VAV
   4. Terminal Reheat.
   5. Duct statis Pressure Transmitter
   6. Differential Pressure Transmitter for hydronic pump control

U. Color code shall be as follows and are to match the colors as outlined in Owner's standard color codes:
   1. High Pressure Steam 125 PSIG and > Dark Red
   2. Medium Pressure Steam <125 PSIG and > 15 PSIG Dark Brown
   3. Low Pressure Steam 5 PSIG and < Light Brown
   4. Condensate Return Black
   5. Chilled & Process Chilled Water Supply Green
   7. Condenser Water Supply Blue
   8. Condenser Water Return Light Blue
   9. Domestic Water Dark Green
   10. Fuel Oil Gray
   11. Natural Gas Yellow
12. Fire Suppression        Red
13. Heating Hot Water Supply Orange
14. Heating Hot Water Return Tan

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic as applicable systems.
C. Measurement of final operating condition of HVAC systems.
D. Sound measurement of equipment operating conditions.
E. Vibration measurement of equipment operating conditions.

1.02  RELATED REQUIREMENTS
A. Section 23 08 00 - Commissioning of HVAC.

1.03  REFERENCE STANDARDS
C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.04  SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   3. Include at least the following in the plan:
      a. Preface: An explanation of the intended use of the control system.
      b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      d. Identification and types of measurement instruments to be used and their most recent calibration date.
      e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      f. Final test report forms to be used.
      g. Detailed step-by-step procedures for TAB work for each system and issue, including:
         1) Terminal flow calibration (for each terminal type).
         2) Diffuser proportioning.
         3) Branch/submain proportioning.
         4) Total flow calculations.
         5) Rechecking.
6) Diversity issues.
h. Expected problems and solutions, etc.
i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
j. Details of how TOTAL flow will be determined; for example:
   1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
   2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
n. Method of checking building static and exhaust fan and/or relief damper capacity.
o. Proposed selection points for sound measurements and sound measurement methods.
p. Methods for making coil or other system plant capacity measurements, if specified.
q. Time schedule for TAB work to be done in phases (by floor, etc.).
r. Description of TAB work for areas to be built out later, if any.
s. Time schedule for deferred or seasonal TAB work, if specified.
t. False loading of systems to complete TAB work, if specified.
u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
v. Interstitial cavity differential pressure measurements and calculations, if specified.
w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
x. Procedures for formal progress reports, including scope and frequency.
y. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least twice a week to Studio JAED; Commissioning Authority and HVAC Controls Contractor.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the Commissioning Authority; Studio JAED and HVAC Controls Contractor within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   4. Provide reports in hard cover letter size 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
   5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
7. Units of Measure: Report data in I-P (inch-pound) units only.
8. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Telephone number of Testing, Adjusting, and Balancing Agency.
   d. Project name.
   e. Project location.
   f. Project Engineer.
   g. Project altitude.
   h. Report date.

H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC MN-1, AABC National Standards for Total System Balance.
   3. SMACNA (TAB).
   4. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/.

E. TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION
A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES
A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING
A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.
3.06 **AIR SYSTEM PROCEDURE**

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 **WATER SYSTEM PROCEDURE**

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
3.08 SCOPE

A. Test, adjust, and balance the following:
   1. HVAC Pumps
   2. Packaged Roof Top Heating/Cooling Units
   3. Air Coils
   4. Induction Units.
   5. Fans
   6. Air Terminal Units
   7. Air Inlets and Outlets

3.09 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer
   2. Model/Frame
   3. HP/BHP
   4. Phase, voltage, amperage; nameplate, actual, no load
   5. RPM
   6. Service factor
   7. Starter size, rating, heater elements
   8. Sheave Make/Size/Bore

B. V-Belt Drives:
   1. Identification/location
   2. Required driven RPM
   3. Driven sheave, diameter and RPM
   4. Belt, size and quantity
   5. Motor sheave diameter and RPM
   6. Center to center distance, maximum, minimum, and actual

C. Pumps:
   1. Identification/number
   2. Manufacturer
   3. Size/model
   4. Impeller
   5. Service
   6. Design flow rate, pressure drop, BHP
   7. Actual flow rate, pressure drop, BHP
   8. Discharge pressure
   9. Suction pressure
   10. Total operating head pressure
   11. Shut off, discharge and suction pressures
   12. Shut off, total head pressure

D. Cooling Coils:
   1. Identification/number
   2. Location
   3. Service
   4. Manufacturer
   5. Air flow, design and actual
   6. Entering air DB temperature, design and actual
   7. Entering air WB temperature, design and actual
   8. Leaving air DB temperature, design and actual
   9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Saturated suction temperature, design and actual
12. Air pressure drop, design and actual

E. Heating Coils:
1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Water flow, design and actual
7. Water pressure drop, design and actual
8. Entering water temperature, design and actual
9. Leaving water temperature, design and actual
10. Entering air temperature, design and actual
11. Leaving air temperature, design and actual
12. Air pressure drop, design and actual

F. Air Moving Equipment:
1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

G. Return Air/Outside Air:
1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

H. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
10. Number of Belts/Make/Size.
11. Fan RPM.

I. Duct Traverses:
   1. System zone/branch
   2. Duct size
   3. Area
   4. Design velocity
   5. Design air flow
   6. Test velocity
   7. Test air flow
   8. Duct static pressure
   9. Air temperature
   10. Air correction factor

J. Duct Leak Tests:
   1. Description of ductwork under test
   2. Duct design operating pressure
   3. Duct design test static pressure
   4. Duct capacity, air flow
   5. Maximum allowable leakage duct capacity times leak factor
   6. Test apparatus
      a. Blower
      b. Orifice, tube size
      c. Orifice size
      d. Calibrated
   7. Test static pressure
   8. Test orifice differential pressure
   9. Leakage

K. Air Monitoring Stations:
   1. Identification/location
   2. System
   3. Size
   4. Area
   5. Design velocity
   6. Design air flow
   7. Test velocity
   8. Test air flow

L. Flow Measuring Stations:
   1. Identification/number
   2. Location
   3. Size
   4. Manufacturer
   5. Model number
   6. Serial number
   7. Design Flow rate
   8. Design pressure drop
9. Actual/final pressure drop  
10. Actual/final flow rate  
11. Station calibrated setting  

M. Terminal Unit Data:  
1. Manufacturer  
2. Type, constant, variable, single, dual duct  
3. Identification/number  
4. Location  
5. Model number  
6. Size  
7. Minimum static pressure  
8. Minimum design air flow  
9. Maximum design air flow  
10. Maximum actual air flow  
11. Inlet static pressure  

N. Air Distribution Tests:  
1. Air terminal number  
2. Room number/location  
3. Terminal type  
4. Terminal size  
5. Area factor  
6. Design velocity  
7. Design air flow  
8. Test (final) velocity  
9. Test (final) air flow  
10. Percent of design air flow  

O. Sound Level Reports:  
1. Location  
2. Octave bands - equipment off  
3. Octave bands - equipment on  

P. Vibration Tests:  
1. Location of points:  
   a. Fan bearing, drive end  
   b. Fan bearing, opposite end  
   c. Motor bearing, center (if applicable)  
   d. Motor bearing, drive end  
   e. Motor bearing, opposite end  
   f. Casing (bottom or top)  
   g. Casing (side)  
   h. Duct after flexible connection (discharge)  
   i. Duct after flexible connection (suction)  
2. Test readings:  
   a. Horizontal, velocity and displacement  
   b. Vertical, velocity and displacement  
   c. Axial, velocity and displacement  
3. Normally acceptable readings, velocity and acceleration  
4. Unusual conditions at time of test  
5. Vibration source (if non-complying)  

END OF SECTION
SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Duct insulation.
B. Insulation jackets.

1.02 RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Painting insulation jackets.
B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
C. Section 23 31 00 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS
K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE
A. Manufacturer:
B. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Sorption: 5.0 percent by weight.
C. Vapor Barrier Jacket:
1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
2. Secure with pressure sensitive tape.
D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
E. Outdoor Vapor Barrier Mastic:
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
F. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID
A. Manufacturer:
5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Insulation: ASTM C612; rigid, noncombustible blanket.
1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum service temperature: 450 degrees F.
3. Maximum Water Vapor Sorption: 5.0 percent.
C. Vapor Barrier Jacket:
1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
2. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 JACKETS

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive:
      a. Compatible with insulation.

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ducts conveying air above ambient temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with aluminum jacket.

F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with caked aluminum jacket with seams located on bottom side of horizontal duct section.

G. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

H. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES
A. INDOOR DUCT AND PLENUM APPLICATION SCHEDULE
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
4. Service: Rectangular, supply-air ducts, concealed.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
5. Service: Rectangular, return-air ducts, concealed.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
7. Service: Round, supply-air ducts, exposed.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Aluminum, painted to architects specifications.
   d. Vapor Retarder Required: Yes.
e. NOTE: Provide double-wall spiral ductwork in areas noted on drawings as defined in specification section 23 31 00.

   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Aluminum, painted to architects specifications.
   d. Vapor Retarder Required: No.
   e. NOTE: Provide double-wall spiral ductwork in areas noted on drawings as defined in specification section 23 31 00.

   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Aluminum, painted to architects specifications.
   d. Vapor Retarder Required: Yes.
   e. NOTE: Provide double-wall spiral ductwork in areas noted on drawings as defined in specification section 23 31 00.

10. Service: Rectangular, supply-air ducts, exposed.
    b. Thickness: 2 inches, R-6 minimum.
    c. Jacket: Aluminum, painted to architects specifications.
    d. Vapor Retarder Required: Yes.

11. Service: Rectangular, return-air ducts, exposed.
    b. Thickness: 2 inches, R-6 minimum.
    c. Jacket: Aluminum, painted to architects specifications.
    d. Vapor Retarder Required: No.

12. Service: Rectangular, outside-air ducts, exposed.
    b. Thickness: 2 inches, R-6 minimum.
    c. Jacket: Aluminum, painted to architects specifications.
    d. Vapor Retarder Required: Yes.

B. OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

   b. Thickness: 3 inches, R-8 minimum.
   c. Field-Applied Jacket: aluminum
      1) Aluminum Thickness: 0.032 inch
   d. Vapor Retarder Required: Yes.

   b. Thickness: 3 inches, R-8 minimum.
   c. Field-Applied Jacket: aluminum
      1) Aluminum Thickness: 0.032 inch
   d. Vapor Retarder Required: Yes.

3. Service: Rectangular, supply-air ducts.
   b. Thickness: 3 inches, R-8 minimum.
   c. Field-Applied Jacket: aluminum
      1) Aluminum Thickness: 0.032 inch
   d. Vapor Retarder Required: Yes.

4. Service: Rectangular, return-air ducts.
b. Thickness: 3 inches, R-8 minimum.
c. Field-Applied Jacket: aluminum  
   1) Aluminum Thickness: 0.032 inch
d. Vapor Retarder Required: Yes.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Piping insulation.
   B. Jackets and accessories.

1.02 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 09 90 00 - Painting and Coating: Painting insulation jacket.
   C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
   D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS
   A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer’s identification, product density, and thickness.

1.07 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER
A. Manufacturers:
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 650 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
F. Vapor Barrier Lap Adhesive:
1. Compatible with insulation.

G. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

H. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5x5.

I. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

J. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

K. Outdoor Breather Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

L. Insulating Cement:
   1. ASTM C449/C449M.

2.03 CELLULAR GLASS

A. Manufacturers:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C552, Type 1.
   1. Apparent Thermal Conductivity; 'K' value: Grade 6, 0.33 at 100 degrees F.
   2. Service Temperature: Up to 800 degrees F.
   3. Water Vapor Permeability: 0.005 perm inch.
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 EXPANDED POLYSTYRENE

A. Insulation: ASTM C578; rigid closed cell.
   1. 'K' value: 0.23 at 75 degrees F.
   2. Maximum service temperature: 165 degrees F.
   3. Maximum water vapor permeance: 5.0 perms

2.05 EXPANDED PERLITE

A. Manufacturers:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C610, molded.
   1. Maximum service temperature: 1200 degrees F.
   2. Maximum water vapor transmission: 0.1 perm.

2.06 HYDROUS CALCIUM SILICATE

A. Manufacturers:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
   1. 'K' value: ASTM C177 and C518; 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum service temperature: 1200 degrees F.
C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Insulating Cement:
   1. ASTM C449/C449M.

2.07 POLYISOCYANURATE CELLULAR PLASTIC
A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
   1. Dimension: Comply with requirements of ASTM C585.
   2. 'K' Value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
   3. 'K' value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
   4. Minimum Service Temperature: -70 degrees F.
   5. Maximum Service Temperature: 300 degrees F.
   6. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.
   7. Moisture Vapor Transmission: 4.0 perm in.

2.08 POLYETHYLENE
A. Manufacturers:
   1. Armacell LLC: www.armacell.us/#sle.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying with applicable requirements of ASTM D1056.
   1. 'K' value: ASTM C177; 0.25 at 75 degrees F.
   2. Maximum Service Temperature: 300 degrees F.
   4. Maximum Moisture Absorption: 1.0 percent by volume.
   5. Moisture Vapor Permeability: 0.05 perm inch, when tested in accordance with ASTM E96/E96M.
   6. Connection: Contact adhesive.

2.09 FLEXIBLE ELASTOMERIC CELLULAR INSULATION
A. Manufacturer:
   1. Armacell LLC: www.armacell.us/#sle.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
   1. Minimum Service Temperature: -40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.10 JACKETS
A. PVC Plastic.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
d. Thickness: 10 mil.
e. Connections: Brush on welding adhesive.

3. Covering Adhesive Mastic:
   a. Compatible with insulation.

B. ABS Plastic:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: -40 degrees F.
      b. Maximum Service Temperature of 180 degrees F.
      c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
   d. Thickness: 30 mil.
   e. Connections: Brush on welding adhesive.

C. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive:
      a. Compatible with insulation.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

E. Stainless Steel Jacket: ASTM A666, Type 302 stainless steel.
   1. Thickness: 0.010 inch.
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations. Finish with PVC jacket.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Pipe Not Concealed Above Ceilings: Finish with PVC jacket.

L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

A. PIPING INSULATION SCHEDULES
   1. General: Abbreviations used in the following schedules include:

B. INTERIOR PIPING APPLICATION SCHEDULE
   1. Service: Condensate drain piping.
      a. Operating Temperature: 35 to 75 deg F.
      b. Insulation Material: Flexible elastomeric.
      c. Insulation Thickness: 0.5 inch.
      d. Jacket: None.
      e. Vapor Retarder Required: Yes.
      f. Finish: None.
   2. Service: Chilled-water supply and return.
      a. Operating Temperature: 35 to 250 deg F.
      b. Insulation Material: Mineral fiber or glass fiber.
      c. Insulation Thickness: Apply the following insulation thicknesses:
         1) Pipe, 1" or less: 1.0 inch.
         2) Pipe, 1 ¼" and up: 1.5 inch.
      d. Jacket: PVC.
      e. Vapor Retarder Required: Yes.
      a. Operating Temperature: 100 to 250 deg F.
      b. Insulation Material: Mineral fiber or glass fiber.
c. Insulation Thickness: Apply the following insulation thicknesses:
   1) Pipe, 1” or less: 1.0 inch.
   2) Pipe, 1-1/4” to 4”: 1.5 inch.
   3) Pipe, 5” and up: 2.0 inch.

d. Jacket: PVC where not concealed above ceilings.

e. Vapor Retarder Required: No.

f. Finish: None.

END OF SECTION
SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Dampers.
B. Damper Operators:
   1. Electric operators.
C. Input/Output Sensors:
   1. Temperature sensors.
D. Thermostats, Temperature Sensors.
E. Automatic dampers.
F. Damper operators.
G. Miscellaneous accessories.

1.02 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps.
B. Section 23 33 00 - Air Duct Accessories: Installation of automatic dampers.
C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
D. Section 23 09 23 - Direct-Digital Control System for HVAC.
E. Section 23 09 93 - Sequence of Operations for HVAC Controls.

1.03 REFERENCE STANDARDS
A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
D. Manufacturer's Instructions: Provide for all manufactured components.
E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE
   A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL
   A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 DAMPERS
   A. Performance: Test in accordance with AMCA 500-D.
   B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage.
   C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.
   D. Blade Seals: Synthetic elastomeric inflatable mechanically attached, field replaceable.
   E. Jamb Seals: Spring stainless steel.
   F. Shaft Bearings: Oil impregnated sintered bronze.
   G. Linkage Bearings: Oil impregnated sintered bronze.
   H. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.
   I. Maximum Pressure Differential: 6 inches wg.
   J. Temperature Limits: -40 to 200 degrees F.

2.03 DAMPER OPERATORS
   A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
      1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
      2. Provide one operator for maximum 36 sq ft damper section.
   B. Electric Operators:
      1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.04 INPUT/OUTPUT SENSORS
   A. Temperature Sensors:
      1. Sensor range shall provide a resolution of no worse than .4°F (unless noted otherwise).
      2. Space Temperature Sensors:
         a. General room temperature sensor, other than those provided with VRF equipment, shall be an element contained within a ventilated cover, suitable for wall mounting with digital output. Provide insulated base.
         b. Sensors located in mechanical areas, plenums, garages, gymnasiums, corridors, cafeterias, restrooms, or designated institutional locations shall be a flat plate sensor.
with no possible adjustment. Security screws shall be used in institutional settings as deemed necessary by the design engineer. ATC contractor shall coordinate requirements with the design engineer during the submittal process. Provide insulated base.

   c. Following sensing elements are acceptable:
      1) Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.
      2) Units shall be capable of +/- 2 degrees (F) adjustment by the occupant, with display showing current temperature and setpoint.

   3. Single point duct temperature sensor shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
      a. Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.

   4. Averaging duct temperature sensor shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide enough sensors to give one lineal foot of sensing element for each square foot of cooling coil face area. Temperature range as required for resolution indicated in paragraph A.
      a. Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.

   5. Liquid immersion temperature sensor shall include stainless steel thermowell, sensor and connection head for wiring connections.
      a. Sensing element for chilled water applications - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point. Temperature range shall be as required for resolution indicated in paragraph A.
      b. Sensing element for non-chilled water applications - Platinum RTD, +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of no worse than 0.1°F.

   B. Equipment Operation Sensors:
      1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
      2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.

   C. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

   D. Carbon Dioxide Level Sensors:
      1. Wall or duct-mounted as required by control sequence or plans.
      2. Demand-control ventilation sensor for measuring and transmitting CO2 levels ranging from 0-2,000 ppm.
      4. Proportional output, 4-20 mA signal.

2.05 THERMOSTATS

   A. Line Voltage Thermostats:
      1. Integral manual On/Off/Auto selector switch, single or two pole as required.
      2. Dead band: Maximum 2 degrees F.
      3. Cover: Locking with set point adjustment, with thermometer.
B. Outdoor Reset Thermostat:
   1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
   2. Scale range: -10 to 70 degrees F.

C. Immersion Thermostat:
   1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

D. Airstream Thermostats:
   1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
   2. Averaging service remote bulb element: 7.5 feet.

E. Electric Low Limit Duct Thermostat:
   1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
   2. Bulb length: Minimum 20 feet.
   3. Provide one thermostat for every 20 sq ft of coil surface.

F. Electric High Limit Duct Thermostat:
   1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
   2. Bulb length: Minimum 20 feet.
   3. Provide one thermostat for every 20 sq ft of coil surface.

G. Fire Thermostats:
   1. UL labeled, factory set in accordance with NFPA 90A.

H. Heating/Cooling Valve Top Thermostats:
   1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

2.06 TRANSMITTERS

A. Pressure Transmitters:
   1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

B. Temperature Transmitters:
   1. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degree F span and plus or minus 1 percent for 50 degree F span, with 50 degrees F temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that systems are ready to receive work.
C. Beginning of installation means installer accepts existing conditions.
D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
F. Ensure installation of components is complementary to installation of similar components.

G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches, CO2 sensors, and humidistats. Refer to Section 26 2726.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield on a north-facing wall.

E. Provide separable sockets for liquids and flanges for air bulb elements.

F. Provide thermostats in aspirating boxes in front entrances.

G. Provide guards on thermostats in entrances.

H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

I. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

J. Provide isolation (two position) dampers of parallel blade construction.

K. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

N. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of .

O. Install pressure independent balancing and control valves for small terminal units on the supply or return lines of coils.

1. For accuracy in flow measurements try to avoid mounting taps and pumps immediately before or after the valve. A minimum distance of five times the pipe diameter and ten times the pipe diameter before the valve for taps and pump respectively is recommended before the valve. A minimum distance of two times the pipe diameter is recommended after the valve.

2. The actuator for the combined manual balancing and control valves for small terminal units can be installed in any position as per manufacturer’s recommendations.

3. Install in accordance with manufacturer’s instructions.

3.03 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

END OF SECTION
SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Control equipment.
   B. Software.

1.02 RELATED REQUIREMENTS
   A. Section 28 46 00 - Fire Detection and Alarm.
   B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
   C. Section 23 09 93 - Sequence of Operations for HVAC Controls.
   D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
   E. Section 23 09 95 - Laboratory Airflow Control System

1.03 REFERENCE STANDARDS
   A. NFPA 70 - National Electrical Code.
   B. UL (DIR) - Online Certifications Directory.

1.04 SYSTEM DESCRIPTION
   A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units [with communications to the EXISTING Building Management System]. This specification is intended to relay the need to MODIFY THE EXISTING BAS only, not provide a complete new system. Full integration with the existing equipment is required.
   B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
   C. Include computer software and all hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
   D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 0913.
   E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment, power transformers and electrical feeds, and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
   F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data for each system component and software module.
   C. Shop Drawings:
      1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
      2. List connected data points, including connected control unit and input device.
      3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include submittals data in final "Record Documents" form.

F. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE
A. Perform work in accordance with NFPA 70.
B. Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
D. Installer Qualifications: Company specializing in performing the work of this section 5 years documented experience approved by manufacturer.
E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this Section.
B. Require attendance of parties directly affecting the work of this Section.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Correct defective Work within a five year period after Substantial Completion.
C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.09 MAINTENANCE SERVICE
A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
B. Provide four complete inspections per year, two in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
C. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.
1.10 EXTRA MATERIALS
   A. See Section 01 60 00 - Product Requirements, for additional provisions.

1.11 PROTECTION OF SOFTWARE RIGHTS
   A. Prior to delivery of software, the Owner and the party providing the software will enter into a
      software license agreement with provisions for the following:
      1. Limiting use of software to equipment provided under these specifications.
      2. Limiting copying.
      3. Preserving confidentiality.
      4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   B. Substitutions: See Section 01 60 00 - Product RequirementsNot Permitted.

2.02 OPERATOR STATION
   A. Work Station:
      1. Utilize owner-provided mobile laptop for interface.
   B. System Support: Minimum ten (10) work stations connected to multi-user, multi-tasking
      environment with concurrent capability to:
      1. Access DDC network.
      2. Access or control same control unit.
      3. Access or modify same control unit data base.
      4. Archive data, alarms, and network actions to hard disk regardless of what application
         programs are being currently executed.
      5. Develop and edit data base.
      6. Implement and tune DDC control.
      7. Develop graphics.
      8. Control facility.

2.03 CONTROL UNITS
   A. Units: Modular in design and consisting of processor board with programmable RAM memory,
      local operator access and display panel, and integral interface equipment.
   B. Battery Backup: For minimum of 48 hours for complete system including RAM without
      interruption, with automatic battery charger.
   C. Control Units Functions:
      1. Monitor or control each input/output point.
      2. Completely independent with hardware clock/calendar and software to maintain control
         independently.
      3. Acquire, process, and transfer information to operator station or other control units on
         network.
      4. Accept, process, and execute commands from other control unit's or devices or operator
         stations.
      5. Access both data base and control functions simultaneously.
      6. Record, evaluate, and report changes of state or value that occur among associated
         points. Continue to perform associated control functions regardless of status of network.
      7. Perform in stand-alone mode:
         a. Start/stop.
         b. Duty cycling.
         c. Automatic Temperature Control.
d. Demand control via a sliding window, predictive algorithm.
e. Event initiated control.
f. Calculated point.
g. Scanning and alarm processing.
h. Full direct digital control.
i. Trend logging.
j. Global communications.
k. Maintenance scheduling.

D. Global Communications:
1. Broadcast point data onto network, making that information available to all other system control units.
2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.

E. Input/Output Capability:
1. Discrete/digital input (contact status).
2. Discrete/digital output.
3. Analog input.
4. Analog output.
5. Pulse input (5 pulses/second).
6. Pulse output (0-655 seconds in duration with 0.01 second resolution).

F. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control unit's with minimum 30 percent spare capacity.

G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.

I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
2. Control output points but change only data base state or value; leave external field hardware unchanged.
3. Enable control actions on output points but change only data base state or value.

J. Local display and adjustment panel: Portable control unit, containing digital display, and numerical keyboard. Display and adjust:
1. Input/output point information and status.
2. Controller set points.
3. Controller tuning constants.
4. Program execution times.
5. High and low limit values.
7. Set/display date and time.
8. Control outputs connected to the network.
10. Perform control unit diagnostic testing.
11. Points in "Test" mode.
2.04 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).
B. LAN Capacity: Not less than 100 stations or nodes.
C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
D. LAN Data Speed: Minimum 19.2 Kb.
E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
F. Transmission Median: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.05 OPERATING SYSTEM SOFTWARE

A. Input/Output Capability From Operator Station:
   1. Request display of current values or status in tabular or graphic format.
   2. Command selected equipment to specified state.
   3. Initiate logs and reports.
   5. Add, delete, or change points within each control unit or application routine.
   6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
   7. Add new control units to system.
   8. Modify and set up maintenance scheduling parameters.
   9. Develop, modify, delete or display full range of color graphic displays.
   10. Automatically archive select data even when running third party software.
   11. Provide capability to sort and extract data from archived files and to generate custom reports.
   12. Support two printer operations.
      a. Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.
      b. Data printer: Print reports, page prints, and data base prints.
   13. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
   14. Print selected control unit data base.

B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.

C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
   1. Add and delete points.
   2. Modify any point parameter.
   3. Change, add, or delete English language descriptors.
   4. Add, modify, or delete alarm limits.
   5. Add, modify, or delete points in start/stop programs, trend logs, etc.
   6. Create custom relationship between points.
   7. Create or modify DDC loops and parameters.
   8. Create or modify override parameters.
   9. Add, modify, and delete any applications program.
10. Add, delete, develop, or modify dynamic color graphic displays.

D. Dynamic Color Graphic Displays:
   1. Utilizes custom symbols or system supported library of symbols.
   2. Sixteen (16) colors.
   3. Sixty (60) outputs of real time, live dynamic data per graphic.
   4. Dynamic graphic data.
   5. 1,000 separate graphic pages.
   6. Modify graphic screen refresh rate between 1 and 60 seconds.

E. Operator Station:
   1. Accept data from LAN as needed without scanning entire network for updated point data.
   2. Interrogate LAN for updated point data when requested.
   3. Allow operator command of devices.
   4. Allow operator to place specific control units in or out of service.
   5. Allow parameter editing of control units.
   6. Store duplicate data base for every control unit and allow down loading while system is on line.
   7. Control or modify specific programs.
   8. Develop, store and modify dynamic color graphics.
   9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.

F. Alarm Processing:
   1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and which alarms shall cause automatic dial-out.
   2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
   3. Print on line changeable message, up to 100 characters in length, for each alarm point specified.
   4. Display alarm reports on video. Display multiple alarms in order of occurrence.
   5. Define time delay for equipment start-up or shutdown.
   6. Allow unique routing of specific alarms.
   7. Operator specifies if alarm requires acknowledgement.
   8. Continue to indicate unacknowledged alarms after return to normal.
   9. Alarm notification:
      a. Automatic print.
      b. Display indicating alarm condition.
      c. Selectable audible alarm indication.

G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.

H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

I. Messages:
   1. Automatically display or print user-defined message subsequent to occurrence of selected events.
   2. Compose, change, or delete any message.
   3. Display or log any message at any time.
   4. Assign any message to any event.
J. Reports:
   1. Manually requested with time and date.
   2. Long term data archiving to hard disk.
   3. Automatic directives to download to transportable media such as floppy diskettes for storage.
   4. Data selection methods to include data base search and manipulation.
   5. Data extraction with mathematical manipulation.
   6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
   7. Generating reports either normally at operator direction, or automatically under work station direction.
   8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
   9. Include capability for statistical data manipulation and extraction.
   10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.

K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Data Collection:
   1. Automatically collect and store in disk files.
   2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2 year period.
   3. Daily consumption for up to 30 meters over a 2 year period.
   4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
   5. Provide archiving of stored data for use with system supplied custom reports.

M. Graphic Display: Support graphic development on work station with software features:
   1. Page linking.
   2. Generate, store, and retrieve library symbols.
   3. Single or double height characters.
   4. Sixty (60) dynamic points of data per graphic page.
   5. Pixel level resolution.
   6. Animated graphics for discrete points.
   7. Analog bar graphs.
   8. Display real time value of each input or output line diagram fashion.

N. Maintenance Management:
   1. Run time monitoring, per point.
   2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
   3. Equipment safety targets.
   4. Display of maintenance material and estimated labor.
   5. Target point reset, per point.

O. Advisories:
   1. Summary which contains status of points in locked out condition.
   2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
   3. Report of power failure detection, time and date.
   4. Report of communication failure with operator device, field interface unit, point, programmable control unit.
2.06 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and SI (metric) units of measurement.

B. Demand Limiting:
   1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
   2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
   4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
   5. Demand Target: Minimum of 3 per demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
   6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
   7. Limits: Include control band (upper and lower limits).
   8. Output advisory if loads are not available to satisfy required shed amount, advise shed requirements and requiring operator acknowledgement.

C. Duty Cycling:
   1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
   2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.
   3. Set and modify following parameters for each individual load.
      a. Minimum and maximum Off time.
      b. On/Off time in one minute increments.
      c. Time period from beginning of interval until load can be cycled.
      d. Manually override the DCC program and place a load in an On or Off state.
      e. Cooling Target Temperature and Differential.
      f. Heating Target Temperature and Differential.
      g. Cycle off adjustment.

D. Automatic Time Scheduling:
   2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
   3. Special days schedule shall support up to 30 unique date/duration combinations.
   4. Any number of loads assigned to any time program; each load can have individual time program.
   5. Each load assigned at least 16 control actions per day with 1 minute resolution.
   6. Time schedule operations may be:
      a. Start.
      b. Optimized Start.
      c. Stop.
      d. Optimized Stop.
      e. Cycle.
      f. Optimized Cycle.
   7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
   8. Create temporary schedules.
   9. Broadcast temporary "special day" date and duration.

E. Start/Stop Time Optimization:
   1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
   2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
   a. Occupancy period.
   b. Desired temperature at beginning of occupancy period.
   c. Desired temperature at end of occupancy period.

F. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
   1. Employ arithmetic, algebraic, Boolean, and special function operations.
   2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.

H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
   1. Define time interval between each control action between 0 to 3600 seconds.
   2. Output may be analog value.
   3. Provide for "skip" logic.
   4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.

I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
   1. Control loops: Defined using "modules" that are analogous to standard control devices.
   2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
   3. Firmware:
      a. PID with analog or pulse-width modulation output.
      b. Floating control with pulse-width modulated outputs.
      c. Two-position control.
      d. Primary and secondary reset schedule selector.
      e. Hi/Lo signal selector.
      f. Single pole double throw relay.
      g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
   4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
   5. Display: Value or state of each of the lines which interconnect DDC modules.

J. Fine Tuning Direct Digital Control PID or floating loops:
   1. Display information:
      a. Control loop being tuned
      b. Input (process) variable
      c. Output (control) variable
      d. Setpoint of loop
      e. Proportional band
      f. Integral (reset) Interval
      g. Derivative (rate) Interval
   2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".

K. Trend logging:
   1. Each control unit will store samples of control unit's data points.
2. Update file continuously at discretely assignable intervals.
3. Automatically initiate upload request and then store data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with on/off state of specified point.
6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.

2.07 HVAC CONTROL PROGRAMS

A. General:
   1. Support Inch-pounds and SI (metric) units of measurement.
   2. Identify each HVAC Control system.

B. Optimal Run Time:
   1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
   2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
   3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
   4. Use outside air temperature to determine early shut down with ventilation override.
   5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
   6. Operator commands:
      a. Define term schedule.
      b. Add/delete fan status point.
      c. Add/delete outside air temperature point.
      d. Add/delete mass temperature point.
      e. Define heating/cooling parameters.
      f. Define mass sensor heating/cooling parameters.
      g. Lock/unlock program.
      h. Request optimal run time control summary.
      i. Request optimal run time mass temperature summary.
      j. Request HVAC point summary.
      k. Request HVAC saving profile summary.
   7. Control Summary:
      a. HVAC Control system begin/end status.
      b. Optimal run time lock/unlock control status.
      c. Heating/cooling mode status.
      d. Optimal run time schedule.
      e. Start/Stop times.
      f. Selected mass temperature point ID.
      g. Optimal run time system normal start times.
      h. Occupancy and vacancy times.
      i. Optimal run time system heating/cooling mode parameters.
   8. Mass temperature summary:
      a. Mass temperature point type and ID.
      b. Desired and current mass temperature values.
      c. Calculated warm-up/cool-down time for each mass temperature.
      d. Heating/cooling season limits.
      e. Break point temperature for cooling mode analysis.
   9. HVAC point summary:
C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot
deck and cold deck temperatures on dual duct and multizone systems, single zone unit
discharge temperatures.
2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
   a. Raising cooling temperatures to highest possible value.
   b. Reducing heating temperatures to lowest possible level.
3. Operator commands:
   a. Add/delete fan status point.
   b. Lock/unlock program.
   c. Request HVAC point summary.
   d. Add/Delete discharge controller point.
   e. Define discharge controller parameters.
   f. Add/delete air flow rate.
   g. Define space load and load parameters.
   h. Request space load summary.
4. Control summary:
   a. HVAC control system status (begin/end).
   b. Supply air reset system status.
   c. Optimal run time system status.
   d. Heating and cooling loop.
   e. High/low limits.
   f. Deadband.
   g. Response timer.
   h. Reset times.
5. Space load summary:
   a. HVAC system status.
   b. Optimal run time status.
   c. Heating/cooling loop status.
   d. Space load point ID.
   e. Current space load point value.
   f. Control heat/cool limited.
   g. Gain factor.
   h. Calculated reset values.
   i. Fan status point ID and status.
   j. Control discharge temperature point ID and status.
   k. Space load point ID and status.
   l. Air flow rate point ID and status.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative
humidity; determine energy expended and control outside and return air dampers.
2. Operator commands:
   a. Add/Delete fan status point.
   b. Add/delete outside air temperature point.
c. Add/delete discharge controller point.
d. Define discharge controller parameters.
e. Add/delete return air temperature point.
f. Add/delete outside air dew point/humidity point.
g. Add/delete return air dew point/humidity point.
h. Add/delete damper switch.
i. Add/delete minimum outside air.
j. Add/delete atmospheric pressure.
k. Add/delete heating override switch.
l. Add/delete evaporative cooling switch.
m. Add/delete air flow rate.
n. Define enthalpy deadband.
o. Lock/unlock program.
p. Request control summary.
q. Request HVAC point summary.

3. Control summary:
a. HVAC control system begin/end status.
b. Enthalpy switchover optimal system status.
c. Optimal return time system status.
d. Current outside air enthalpy.
e. Calculated mixed air enthalpy.
f. Calculated cooling cool enthalpy using outside air.
g. Calculated cooling cool enthalpy using mixed air.
h. Calculated enthalpy difference.
i. Enthalpy switchover deadband.
j. Status of damper mode switch.

2.08 PROGRAMMING APPLICATION FEATURES

A. Trend Point:
   1. Sample up to 150 points, real or computed, with each point capable of collecting 100 samples at intervals specified in minutes, hours, days, or month.
   2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:
   1. Allow definition of minimum of 100 messages, each having minimum length of 100 characters for each individual message.
   2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
   3. Output assigned alarm with "message requiring acknowledgement".
   4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:
   1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
   2. Provide program times for each day of week, per point, with one minute resolution.
   3. Automatically generate alarm output for points not responding to command.
   4. Provide for holidays, minimum of 366 consecutive holidays.
   5. Operator commands:
      a. System logs and summaries.
b. Start of stop point.
c. Lock or unlock control or alarm input.
d. Add, delete, or modify analog limits and differentials.
e. Adjust point operation position.
f. Change point operational mode.
g. Open or close point.
h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
i. Begin or end point totalization.
j. Modify totalization values and limits.
k. Access or secure point.
l. Begin or end HVAC or load control system.
m. Modify load parameter.
n. Modify demand limiting and duty cycle targets.

6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
3. Operator commands:
   a. Define single master/multiple master interlock process.
   b. Define logic interlock process.
   c. Lock/unlock program.
   d. Enable/disable interlock process.
   e. Execute terminate interlock process.
   f. Request interlock type summary.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

A. Install all Owner-provided equipment along with all contractor-provided equipment as required to provide a complete, fully functional building automation system.

B. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

C. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

D. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

E. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements.

F. Ensure that all components necessary to execute the sequences of operation are coordinated and installed by all contractors.
3.03 MANUFACTURER’S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 2 day period.

C. Provide basic operator training for ____ persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

3.05 SCHEDULES

A. Input/Output Schedule:
   1. Point Description:
   2. Digital Input:
      a. Demand Meter (kW):
      b. Auxiliary Contact:
      c. Switches:
         1) Switch Closing:
         2) Flow Switch:
         3) Optical:
      d. Current:
      e. Pressure:
   3. Digital Output:
      a. Control Relay:
      b. Solenoid:
      c. Contactor:
   4. Analog Input:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure/Vacuum:
      d. Filter:
      e. Flow:
      f. Current:
      g. Liquid Level:
      h. Photocell:
   5. Analog Output:
      a. Pneumatic Transducer:
      b. 4-20 ma Module:
      c. 0-16 v DC:
   6. Alarm:

B. Input/Output Schedule:
   1. Point Description:
   2. Inputs:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure:
      d. Flow:
      e. Level:
f. Position:
g. Energy:
h. Power:

3. Outputs:
a. Status:
b. Alarm:
c. Pneumatic Position:
d. Electronic Position:
e. Set Point Adjust:
f. Start/Stop:
g. Off/Low/High:

4. Software Features:
a. PID Control (DDC):
b. High Limit:
c. Low Limit:
d. Run Time Totalization:
e. Consumption Totalization:
f. Program Start/Stop:
g. Load Shed:
h. Duty Cycle:
i. Enthalpy Switchover:
j. Optimal Run Time:
k. Supply Air Reset:
l. O.A. Interlock:
m. O.A. Temperature Reset:
n. Free Cooling Mode:
o. Warm-up Mode:
p. Boiler Interlock:
q. Chiller Sequencing:
r. Energy Calculation:

C. Alarm Schedule:

END OF SECTION
SECTON 23 09 95
LABORATORY AIRFLOW CONTROL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Laboratory Airflow Control System (LACS)

1.02 REFERENCES.
A. Abbreviations and Acronyms
1. ATC - Advanced Temperature Control
2. BMS - Building Management System
3. BAS - Building Automation System
4. LACS - Laboratory Airflow Control System
5. VAV - Variable Air Volume
6. PIN - Personal Identification Number

B. Reference Standards
1. Air Conditioning and Refrigeration Institute
   a. ARI 880 Performance Rating of Air Terminals
   b. American Society of Heating, Refrigeration, and Air Conditioning Engineers / American National Standards Institute
      1) ASHRAE/ANSI Standard 130, Methods for Testing Air Terminal Units
   c. American National Standards Institute / American Society of Heating, Refrigeration, and Air Conditioning Engineers

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination
1. The LACS representative shall coordinate all details of the installation with the successful mechanical contractor. This effort shall include complete coordination of the sheet metal layout drawings to assure that the ductwork layout and sizing is based on the actual sizes of the airflow control valves for this project.

B. Pre-installation Meetings
1. The LACS representative shall review the proper installation of the system with the sheet metal contractor and the building management system (BMS) contractor.
2. Project Installation Phase - The LACS representative shall make periodic visits to the project jobsite to assure that the system is being installed properly to assure optimal performance and that the location and orientation of the control valves is consistent for proper operation and future owner maintenance. Any discrepancies shall first be brought to the attention of the appropriate subcontractor. If no action is taken by said contractor, the representative shall bring these issues to the project manager, engineer or owner’s representative for resolution.

1.04 SUBMITTALS
A. General: Submit listed Submittals in accordance with Conditions of the General Contract and Division 1 Submittal Procedures Section. LACS submittals shall contain, at a minimum, the following information:
1. Product Data Sheets
2. Equipment Schedule Sheets containing Room#, Tag#, Min/Max flows, Catalog# and other configuration data as required to provide a fully engineered LACS
3. Installation Instructions
4. Project-specific Wiring Diagrams
5. Points Lists

1.05 CLOSEOUT SUBMITTALS
   A. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided as closeout submittals.
   B. Integration checklists are encouraged; once the integration to the BMS or BAS is completed, it is recommended that the Phoenix Controls Representative Partner meet with the BMS or BAS contractor to do a final acceptance test of the integration. This testing should include:
      1. Testing points to ensure communication
      2. Testing setpoints such as temperature, occupancy, room offset, etc
      3. Testing various alarms in different parts of the system
      4. Testing to ensure that equipment will cycle after a power loss

1.06 QUALITY ASSURANCE
   A. Certifications
      1. The laboratory airflow system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001:2008.
      2. The Laboratory airflow system provider shall be ROHS compliant in all its products
      3. The Venturi valves shall be calibrated on NVLAP accredited air stations.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Storage and Handling Requirements
      1. Prior to installation, the LACS shall be stored in dry conditions within an environment complying with LACS product specifications as shown on product data sheets within the submittals.
      2. The LACS products shall be handled and transported in a manner consistent trade practices for control systems and instruments.

1.08 SITE CONDITIONS
   A. The ambient environmental conditions during installation and operation shall comply with LACS product specifications as shown on the product data sheets within the submittals.

1.09 WARRANTY
   A. The Warranty shall commence upon the date of shipment and extend for a period of 60 months for all airflow control devices and 36 months for all other control system components.

PART 2 PRODUCTS

2.01 LABORATORY AIRFLOW CONTROL SYSTEMS
   A. A LACS shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust flow rate of a laboratory fume hood shall be controlled precisely to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on an operator’s presence in front of the fume hood. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates and maintain laboratory pressurization in relation to adjacent spaces (positive or negative). The LACS shall be capable of operating as a standalone system or as a system integrated with the Building Management System (BMS). An optional locally mounted user interface terminal shall be available to allow room-level control variables to be displayed, and where appropriate, edited to adjust control operation.

2.02 COMPONENTS
   A. AIRFLOW CONTROL DEVICE - GENERAL
1. The airflow control device shall be a Phoenix Controls Accel II pressure independent venturi valve.
4. All Components of the valve, its controllers, and wiring shall be ROHS compliant.
5. The airflow control device shall be mechanically pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change (within product specifications) or quantity of airflow controllers on a manifolded system.
6. The airflow control device shall maintain accuracy within ±5% of signal to set point over an airflow turndown range of no less than:
   a. 12.5 to 1 (medium pressure all valve sizes)
   b. 16 to 1 (medium pressure w/o 14” valve)
   c. 7 to 1 (low pressure all valve sizes)
   d. 11 to 1 (low pressure w/o 14” valve)
   e. 8 to 1 (medium pressure shut-off all valve sizes)
   f. 14 to 1 (medium pressure shut-off w/o 14” valve)
   g. 5 to 1 (low pressure shut-off all valve sizes)
   h. 9 to 1 (low pressure shut-off w/o 14” valve)
   i. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
   j. No rotational/axial orientation requirements shall be required to ensure accuracy and/or pressure independence.
   k. The airflow control device shall maintain pressure independence regardless of loss of power. “Electronically pressure independent” devices will not be acceptable.
   l. Airflow control devices utilizing ASHRAE 130 minimum operating pressure as a rating for minimum design pressure at required flow will not be acceptable on basis on minimum operating pressure alone. Valve manufacturer will provide minimum required differential pressure in writing for each size valve they offer.
   m. Airflow control device shall be able to achieve its maximum turndown ratio at its stated minimum operating differential pressure. I.E. if minimum operating pressure is 0.6” wc dp, a 10” air valve must be able to achieve its minimum of 50cfm and its maximum of 1000 cfm at stated 0.6” wc dp. Devices that require duct static pressure to be increased to achieve maximum flow shall not be acceptable.
   n. The airflow control device shall be constructed of one of the following four types:
      1) Class A-The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device’s shaft and internal “S” link shall be made of 316 stainless steel. The shaft support brackets shall be made of galvanal (non shutoff valves) or 316 stainless steel (shutoff valves). The pivot arm shall be made of aluminum (for non shutoff valves) and 303/304 stainless (for shut off valves). The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a PP (polypropylene) or PPS (polyphenylene sulfide) composite. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.
         (a) Note: Airflow Control Devices utilizing vortex shedding sensors and installed in fume hoods or corrosive environments MUST be constructed with
Stainless steel bodies, and MUST have stainless steel Vortex Shedding sensors. PolyCarbonate Vortex Shedding sensors will NOT be acceptable in corrosive environments.

o. Actuation
1) For Standard Speed electrically actuated VAV operation, a CSA certified, UL recognized (IP54 rating and CE certification optional on single valves, standard on dual valves) electronic actuator shall be factory mounted to the valve. The fail-safe state for standard speed operation valves shall be fail to last position unless otherwise noted.
   (a) In fail-safe conditions the Airflow Control Device must remain pressure independent and in control of airflow at its failed position. I.E. if a device fails in position at 500 cfm, the airflow control device must remain pressure independent regardless of having power/controller operating and will deliver the 500cfm at that given control point regardless of duct pressure. Airflow control devices with single or dual blades that fail in position or fail open will not be acceptable as the airflow delivered cannot be guaranteed due to device not being mechanically pressure independent.
   (1) During normal operation, the standard speed actuated airflow control device shall initiate valve movement and achieve the commanded airflow value with no more than 5% overshoot or undershoot within 60 seconds (90 seconds for a shutoff valve from shutoff to maximum flow or vice versa).

p. The controller for the airflow control devices shall be microprocessor based and operate using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network. The room-level control network shall utilize a LonTalk communications protocol.

q. There shall be no reliance on external or building-level control devices to perform room-level control functions. Each laboratory control system shall have the capability of performing fume hood control, pressurization control, standard and advanced temperature control, humidity control, and implement occupancy and emergency mode control schemes. A Room controller or PLC performing these functions shall not be acceptable.

r. The LACS shall have the option of digital integration with the BMS or BAS. If digital integration device, room controller, laboratory space controller or similar is lost or offline or fails then the valve controllers shall have distributed controllability and will keep the basic room functions of zone balance, temperature, humidity control, offset control, etc. operating to maintain a safe and comfortable zone.

s. NVLAP Accreditation (Lab Code 200992-0)
1) Each airflow control device shall be factory characterized on air stations NVLAP Accredited (a program administered by NIST) to ISO/IEC 17025:2005 standards.
2) Each airflow control device shall be factory characterized to the job specific airflows as detailed on the plans and specifications using NVLAP Accredited air stations and instrumentation having a combined accuracy of no more than ±1% of signal (5,000 to 250cfm), ±2% of signal (249 to 100cfm) and ±3% of signal (199 to 35cfm). Electronic airflow control devices shall be further characterized and their accuracy verified to ±5% of signal at a minimum of 48 different airflows across the full operating range of the device.
3) Each airflow control device shall be marked with device-specific factory characterization data. At a minimum, it should include the room number, tag number, serial number, model number, eight-point characterization information (for electronic devices), date of manufacture and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built
documentation. Characterization data shall be stored indefinitely by the manufacturer and backed up off site for catastrophic event recovery.

B. EXHAUST AND SUPPLY AIRFLOW DEVICE CONTROLLER

1. The airflow control device shall be a microprocessor-based design and shall use closed loop control to linearly regulate airflow based on a digital control signal. The device shall generate a digital feedback signal that represents its airflow.

2. During normal operation the airflow control device shall initiate valve movement and achieve the commanded airflow value with no more than 5% overshoot or undershoot within:
   a. 1 second or less with high speed actuation.
   b. 60 seconds for standard speed actuation (90 seconds from shutoff to max flow and vice versa).
   c. The airflow control device shall store its control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or to be networked with other room-level digital airflow control devices using an industry standard protocol.
   d. Room-level control functions shall be embedded in and carried out by the airflow device controller using distributed control architecture. Critical control functions shall be implemented locally; no separate room-level controller shall be required.
   e. The airflow control device shall use industry standard 24 VAC power.
   f. The airflow control device shall have provisions to connect a Phoenix Controls Workbench (WKB100) commissioning tool and every node on the network shall be accessible from any point in the system.
   g. The airflow control device shall have built-in integral input/output connections that address fume hood control, temperature control, humidity control occupancy control, emergency control, and non-network sensors switches and control devices. At a minimum, the airflow controller shall have:
      1) Three universal inputs capable of accepting 0 to 10 VAC, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.
      2) One digital input capable of accepting a dry contact or logic level signal input.
      3) Two analog outputs capable of developing either a 0 to 10 VAC @ 1 mA (10Kohm min) or 4 to 20 mA (500 ohm max) linear control signal.
      4) One Form C (SPDT) relay output capable of driving up to 1 A @ 24 VAC/VAC.
   h. The airflow control device shall meet FCC Part 15 Subpart J Class A, CE, and CSA Listed per file #228219.
   i. The airflow control device shall be ROHS compliant.

2.03 ACCEPTABLE MANUFACTURERS

A. Manufacturer List
   1. The plans and specifications for the LACS are based on systems and equipment manufactured by Phoenix Controls.

B. Substitute Limitations
   1. Phoenix Controls is sole source - no substitutions allowed.

2.04 PERFORMANCE/DESIGN CRITERIA

A. Each laboratory shall have a dedicated LACS. Each dedicated LACS shall support a minimum of 20 network controlled airflow devices.

B. The LACS shall maintain specific airflow (±5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change, airflow change or quantity of airflow control devices on the manifold (within 0.3" to 3.0" wc).

C. The LACS shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in
room/system conditions, such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems using differential pressure measurement, vortex shedding measurement, or velocity measurement to control room pressurization are unacceptable.

D. The LACS shall maintain specific airflow (±5% of signal) with a minimum turndown as specified in 2.2.B.4 to ensure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.

E. Airflow Control Sound Specification
1. The LACS manufacturer shall provide comprehensive sound power level data for each size airflow control device. All data shall be obtained from testing in accordance with ASHRAE/ANSI Standard 130, Methods of Testing Air Terminal Units.
2. All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance.

2.05 OPERATION SEQUENCES
A. The airflow control devices shall utilize peer-to-peer, distributed control architecture to perform room-level control functions. Master-slave control schemes shall not be acceptable. Control functions shall include, at a minimum, volumetric offset pressurization, temperature, humidity control, as well as respond to hood flow demands, occupancy, and emergency control commands.

B. Volumetric Offset Pressurization Control
1. The laboratory control system shall control supply and auxiliary exhaust airflow devices to maintain a volumetric offset (either positive or negative). Offset shall be maintained regardless of any change in flow or static pressure (within specified range for medium or low pressure valves). This offset shall be field adjustable and represents the volume of air, which will enter (or exit) the room from the corridor or adjacent spaces.
2. The pressurization control algorithm shall sum the flow values of all supply and exhaust airflow devices and command appropriate controlled devices to new set points to maintain the desired offset. The offset shall be adjustable as a configurable parameter in the LACS as set by startup technician or BMS/BAS.
3. The pressurization control algorithm shall consider both networked devices, as well as:
   a. Up to three non-networked devices providing a linear analog flow signal.
   b. Any number of constant volume devices where the total of supply devices and the total of exhaust devices may be factored into the pressurization control algorithm.

   1) Volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as a means of control shall provide documentation to demonstrate that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.

   2) The volumetric offset control algorithm shall support the ability to regulate the distribution of total supply flow across multiple supply airflow control devices in order to optimize air distribution in the space.

C. Temperature Control
1. One of the below temperature control methods shall be utilized to achieve temperature control within +/- 1 deg F of setpoint.
2. Standard Primary Temperature Control
   a. The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices. The laboratory control system shall support up to four separate temperature zones for each pressurization zone. Each zone shall have provisions for monitoring up to five temperature inputs and calculating a straight-line
average to be used for control purposes. Separate cooling and heating set points shall be writeable from the BMS, with the option of a local offset adjustment.

b. Temperature control shall be implemented through independent primary cooling and heating control functions. Primary heating shall be provided through the use of a modulating control of a properly sized reheat coil. Primary cooling shall be provided as a function of volumetric override or through auxiliary modulating control of a chilled water valve. Volumetric override will command both supply and general exhaust valves to maintain desired setpoint as a high select zone control. Volumetric cooling override may be staged before or after chilled water control valve.

c. Advanced Temperature Control (ATC) or Cascade Control
   1) The primary temperature control loop for the lab is based on a comparison between the discharge air temperature and the set point for the discharge air. The space temperature measured by a wall sensor is used to reset the set point for discharge air. The set point may be calculated automatically by using “Adaptive Set Point Range”. Another method enabling “Exhaust Air Temperature Adjustment” will calculate the difference between space temperature and exhaust temperature (within 2.7 degrees F) to reset the set point for the discharge air. The reset schedule for the set point is driven by a small window of temperature above and below the desired room temperature in the space.

d. Thermal Anticipatory Control (BTU Compensation) Thermal
   1) Anticipatory Control monitors discharge air temperature sensors, space temperature sensors, and discharge air flow to respond to significant (programmable) changes in air flow to immediately adjust temperature control.

D. Occupancy Control
   1. The laboratory control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the BMS as a scheduled event or through the use of a local occupancy sensor or switch. The laboratory control system shall support a local occupancy override button that allows a user to override the occupancy mode and set the space to occupied for a predetermined interval. The override interval shall be configurable from one to 1440 minutes. The local occupancy sensor/switch or bypass button shall be given priority over a BMS command.

E. Emergency Mode Control
   1. The laboratory control system shall provide a means of overriding temperature and pressurization control in response to a command indicating an emergency condition exists, and airflow control devices are to be driven to a specific flow set point. The system shall support up to four emergency control modes (zone or valve level). The emergency control modes may be initiated either by a local contact input or BMS command. Valve level emergency modes can be individually programmed on each valve as one of four emergency control modes. Zone level emergency modes will drive supply and exhaust valves to maintain or ignore zone offset (excludes control of hood valves).
   2. Once an emergency mode is invoked, pressurization and temperature control are overridden for the period that the mode is active. Emergency modes shall have a priority scheme allowing a more critical mode to override a previously set condition.

2.06 INTERFACE TO BUILDING MANAGEMENT SYSTEMS
   A. The LACS shall tie into the existing LACS building network to integrate to the building automation system (BAS).
   B. Integration Points
      1. As a minimum, the device shall provide these typical integration points (list not all inclusive).
Table 1. Typical Integration Points (not all inclusive)

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Description</th>
<th>Data Type</th>
<th>Read/Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm Points (available on any digital valve controller)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLOW_ALARM</td>
<td>The pressure switch detected low static pressure</td>
<td>Binary</td>
<td>Read Only</td>
</tr>
<tr>
<td>Flow Points (available on any digital valve controller)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFF_VLV_FLOW_CMD</td>
<td>Valve flow set point</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>VLV_FLOW_FDBK</td>
<td>Valve flow feedback</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>Points Associated with Occupancy Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCCUPANCY_CMD</td>
<td>Commanded room occupancy state (occupied/unoccupied/standby)</td>
<td>Multi-State</td>
<td>Read/Write</td>
</tr>
<tr>
<td>EFF_OCC_MODE</td>
<td>Current room occupancy status (occupied/unoccupied/standby/bypass)</td>
<td>Multi-State</td>
<td>Read Only</td>
</tr>
<tr>
<td>Points Associated with Emergency Mode Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFF_EMER_MODE</td>
<td>Present emergency mode status (none, 1, 2, 3, or 4 active)</td>
<td>Multi-State</td>
<td>Read Only</td>
</tr>
<tr>
<td>EMER_MODE_CMD</td>
<td>Commanded emergency mode state (1, 2, 3, or 4)</td>
<td>Multi-State</td>
<td>Read/Write</td>
</tr>
<tr>
<td>Points Associated with Temperature Control (may vary with application)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCC_COOL_SETPT</td>
<td>Cooling set point in the occupied mode</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>OCC_HEAT_SETPT</td>
<td>Heating set point in the occupied mode</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>UNOCC_COOL_SETPT</td>
<td>Cooling set point in the unoccupied mode</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>UNOCC_HEAT_SETPT</td>
<td>Heating set point in the unoccupied mode</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>EFF_TEMP_SETPT</td>
<td>Average of the cooling and heating set points</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>OCC_TEMP_SETPT</td>
<td>Occupied temperature set point</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>AVG_SPACE_TEMP</td>
<td>Average of temperature sensor inputs used for control</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>OFFSET_LEVER_ENABLE</td>
<td>Enables or disables temperature offset lever</td>
<td>Binary</td>
<td>Read/Write</td>
</tr>
<tr>
<td>COOLING_DEMAND</td>
<td>Cooling demand output (-100% = cooling)</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>HEATING_DEMAND</td>
<td>Heating demand output (+100% = heating)</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>DSCHRG_AIR_TEMP</td>
<td>Present value of discharge air temperature sensor</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>DSCHRG_TEMP_SETPT</td>
<td>Discharge air temperature set point (used with Advanced Temperature Control function)</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
<tr>
<td>PCC_TEMP_MODE</td>
<td>Reports current temperature control state</td>
<td>Multi-State</td>
<td>Read Only</td>
</tr>
<tr>
<td>HVAC_MODE_OVERRIDE</td>
<td>Allows BMS to override temperature control to one of eight states (not available on all applications)</td>
<td>Multi-State</td>
<td>Read/Write</td>
</tr>
<tr>
<td>Points Associated with Zone Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFFSET_SETPT</td>
<td>Zone offset set point</td>
<td>Analog</td>
<td>Read/Write</td>
</tr>
<tr>
<td>OFFSET</td>
<td>Calculated zone offset</td>
<td>Analog</td>
<td>Read Only</td>
</tr>
</tbody>
</table>
PART 3 EXECUTION

3.01 INSTALLATION

A. The building management system (BMS) or building automation system (BAS) contractor shall install power wiring and temperature control devices.

B. The BMS shall install an appropriately sized and fused 24 VAC transformer suitable for NEC Class II wiring.

C. All cable shall be furnished and installed by the BMS contractor. The BMS contractor shall terminate and connect all cables as required. The BMS shall utilize cables specifically recommended by the laboratory airflow controls supplier.

D. The mechanical contractor shall install all airflow control devices in the ductwork and shall connect all airflow control valve linkages.

E. The mechanical contractor shall provide and install all reheat coils and transitions.

F. The mechanical contractor shall provide and install insulation as required.

G. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.02 SYSTEM START UP

A. System start-up shall be provided by a factory-authorized representative of the LACS manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment, as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust or return), system programming and integration to BMS (when applicable).

B. The balancing contractor shall be responsible for final verification and reporting of all airflows. For all field flow measurement devices the balancer shall produce a flow report that documents field flows vs device flow and associated error. This to be tabulated for each device location at several flows including min and max. Cost and responsibility to meet the specified performance to be carried by the LACS.

3.03 CLOSEOUT ACTIVITIES

A. Training

1. The LACS supplier shall furnish a minimum of eight hours of owner training by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.

2. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each training attendee.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements (Chilled water, hot water, dual temperature)
B. Hot and chilled water piping, above grade.
C. Pipe and pipe fittings for:
   1. Heating and Chilled water piping system.
   2. Equipment drains and overflows.
D. Pipe hangers and supports.
E. Unions, flanges, mechanical couplings, and dielectric connections.
F. Valves:
   1. Gate valves.
   2. Globe or angle valves.
   3. Ball valves.
   4. Plug valves.
   5. Butterfly valves.
   6. Check valves.
G. Flow controls.

1.02 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.
B. Section 09 91 23 - Interior Painting.
C. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
D. Section 23 07 19 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators.
B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
C. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
F. ASME B31.9 - Building Services Piping.
G. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
H. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.9).
M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
T. AWS D1.1/D1.1M - Structural Welding Code - Steel.

1.04 SYSTEM DESCRIPTION
A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
B. Use grooved mechanical couplings and fasteners in accessible locations.
C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
D. Use non-conducting dielectric connections whenever jointing dissimilar metals.
E. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
F. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
G. Use globe or ball valves for throttling, bypass, or manual flow control services.
H. Use spring loaded check valves on discharge of condenser water pumps.
I. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
J. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.
K. Use lug end butterfly valves to isolate equipment.
L. Use 3/4 inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.05 SUBMITTALS
A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
C. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.
D. Project Record Documents: Record actual locations of valves.
E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
F. Quality Control: Mechanical contractor must submit a copy of its quality control procedures prior to start of work.
G. Soldering / Brazing Certificate: Include certification for soldering and brazing per ASME standards.
H. Submit isometric piping fabrication drawings of the following:
   1. Air handling unit coil connections, including all related valves and instruments.
   2. Heat exchanger connections including all related valves and instruments.

1.06 CLOSE-OUT SUBMITTALS
   A. Balancing report
   B. Hydrostatic Test Report
   C. As-built drawings

1.07 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.
   C. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
   D. Verify field measurements prior to fabrication.
   E. Perform pressure test in compliance with ASME B31.9.
   F. Pressure test must be witnessed by a representative designated by the Owner.

1.08 REGULATORY REQUIREMENTS
   A. Conform to ASME B31.9 code for installation of piping system.
   B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
   C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.09 DELIVERY, STORAGE, AND HANDLING
   A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
   B. Provide temporary protective coating on cast iron and steel valves.
   C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
   D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 FIELD CONDITIONS
   A. Do not install underground piping when bedding is wet or frozen.

1.11 EXTRA MATERIALS
   A. Provide two repacking kits for each size and valve type.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS
   A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
   B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
4. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated. Whether or not indicated, at a minimum, provide at main shut-offs, branch shut-off valves, low points of piping, bases of vertical risers, and at all terminal equipment. Use full port 3/4 inch ball valves with hose end connection for all drain valves. Manual and auto air vents shall be included at all high points in the hydronic systems.
   2. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves. All valves 6” and larger shall be resilient seat butterfly valves, triple sealed, hard backed cartridge seat, wafer body, SS disc, EPDM seal.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

F. All copper pipe greater than 2” diameter shall be brazed. Copper pipe less than 2” diameter can either be brazed or soldered.

G. All soldering and brazing work must be certified per ASME standards. Contractor must submit a copy of the certification prior to work.

H. Risers shall have isolation valves between each floor and at each floor branch. All take offs from mains shall have isolation valves.

I. All branch take offs from piping mains are required to have shut off valves at the take offs so that repairs can be performed on the branch piping without shutting down the system.

J. All manual balancing valves shall be standalone, not combination type, and have a memory setting feature.

2.02 HOT AND CHILLED WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   3. Fittings: All fittings shall be threaded, socket weld or butt weld type and Conform to ASME B31.9.
   4. Joints: Threaded, or AWS D1.1 welded.
   5. All threaded steel pipe less than 2” shall be schedule 80.
   6. All joints larger than 2” diameter shall be welded.

B. Copper Tube: ASTM B280 Type K hard drawn, using the following joint types
   1. All copper fittings shall be wrought copper and comply with ASME B16.
   2. All joints larger than 2” shall be brazed with AWS A5.8M/A5.8 BCuP copper/silver alloy.
   3. Joints 2” and smaller may be soldered with ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver or brazed with AWS A5.8M/A5.8 BCuP copper/silver alloy.
2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   2. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: Solvent welded in accordance with ASTM D2855.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Conform to ASME B31.9.

C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

D. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

F. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.

G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

H. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.

I. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

J. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.

K. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

L. Vertical Support: Steel riser clamp.

M. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

N. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

O. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

P. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

Q. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

R. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

S. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick preformed neoprene.

C. Dielectric Connections: Waterway fitting with water impervious isolation barrier and one galvanized or plated steel end and one copper tube end, end types to match pipe joint types used. Unions are not allowed.

2.06 BALL VALVES
A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Up To and Including 2 Inches:
1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

C. Over 2 Inches:
1. Three piece bronze body, stainless steel ball, teflon seat and stuffing box seals, stainless steel trim, flanged, rated to 800 psi.

D. For hydronic piping less than 200 degrees Fahrenheit (including chilled water), all isolation valves 2-1/2” to 4” shall be flanged three piece bronze full port ball valves with Teflon seats and stainless steel ball and trim.

E. For all hydronic services, isolation valves 2 inches in diameter and smaller shall be two piece, Teflon seated, bronze, full port, w/ stainless steel trim, ball valves. American, Apollo, Milwaukee and Nibco are acceptable valve manufacturers.

2.07 BUTTERFLY VALVES
A. Manufacturers:
1. ABZ
2. Equal by Dezurik or Cameron

B. Body: Cast or ductile iron with triple sealed, hard-backed cartridge seat, wafer body, SS disc resilient replaceable EPDM seal, flanged ends, extended neck.

C. For hydronic piping less than 200 degrees Fahrenheit (including chilled water), all isolation valves 6” and larger shall be resilient seat butterfly valves, tripled sealed, hard backed cartridge seat, wafer body, S.S. disc, EPDM seal, Cameron, DeZurick, ABZ. Gear operators are required for incoming service.

D. For hydronic hot water service over 200 degrees Fahrenheit use High Performance butterfly valves such as ABZ 402-100 with Teflon seat/seal, 17/4PH stainless stem, 316SS disc, or equivalent by Dezurik and Milwaukee (same materials of Construction).

E. Operator: 10 position lever handle or gear drive for incoming services.

2.08 SWING CHECK VALVES
A. Up To and Including 2 Inches:
1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

B. Over 2 Inches:
1. Iron body, stainless steel trim, stainless steel swing disc, renewable disc and seat, flanged or grooved ends.
C. Pump check valves shall be silent type, stainless steel trim with viton seats.

2.09 SPRING LOADED CHECK VALVES
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.10 FLOW CONTROLS
A. Manufacturers:
   1. ITT Bell & Gossett: www.bellgossett.com/#sle.
   2. Tour and Andersson.
   3. Armstrong
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION
3.01 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment using jointing system specified.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Install heating water, chilled water, dual-temperature, and condenser water piping to ASME B31.9 requirements.
C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
E. Install piping to conserve building space and to avoid interfere with use of space.
F. Group piping whenever practical at common elevations.
G. Sleeve pipe passing through partitions, walls and floors.
H. Slope piping and arrange to drain at low points.
I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

K. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Refer to Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.

N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.

O. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.

P. Use eccentric reducers to maintain top of pipe level.

Q. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

R. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 23.

S. Install valves with stems upright or horizontal, not inverted.

T. After completion, flush all hydronic piping systems with clean water until all grease, weld slag and metal filings are removed from system.

U. Provide flanged connections to all equipment.

V. Ensure valve handles and test and balance ports are extended beyond the outside surface of insulation for all piping.

W.

X. Install non-conducting dielectric connections wherever jointing dissimilar metals. All connections shall use dielectric nipples, couplings or insulating flanges. No dielectric unions allowed.
3.03 TESTING

A. Mechanical contractor shall x-ray 10% of the total welds on the project. If any welds fail x-ray examination, contractor shall x-ray 100% of the welds. The contractor is responsible for repairing all welds that failed x-ray examination.

B. Perform pressure test in compliance with ASME B31.9.

C. Pressure test must be witnessed by a representative designated by the Owner.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
   7. 6 inch: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 8 inch: Maximum span, 16 feet; minimum rod size, 5/8 inch.
   9. 10 inch: Maximum span, 18 feet; minimum rod size, 3/4 inch.
  10. 12 inch: Maximum span, 19 feet; minimum rod size, 7/8 inch.

B. Hanger Spacing for Steel Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
  10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
  11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
  12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
  13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
  14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.
  15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.

C. Hanger Spacing for Plastic Piping.
   1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
   2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
   3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
   4. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
   5. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
   6. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
   7. 3 inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   8. 4 inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
   9. 6 inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
  10. 8 inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.
  11. 10 inches: Maximum span, 13 feet; minimum rod size, 3/4 inch.
  12. 12 inches: Maximum span, 14 feet; minimum rod size, 7/8 inch.
  13. 14 inches: Maximum span, 15 feet; minimum rod size, 1 inch.
  14. 16 inches: Maximum span, 16 feet; minimum rod size, 1 inch.
15. 18 inches: Maximum span, 18 feet; minimum rod size, 1-1/4 inch.

END OF SECTION
SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air vents.
   B. Strainers.
   C. Combination fittings.
   D. Flow indicators and controls.
   E. Relief valves.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.
   B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

1.03 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
   C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
   D. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.
   E. Project Record Documents: Record actual locations of flow controls.
   F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
   B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
   C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS
   A. Manufacturers:
      2. ITT Bell & Gossett: www.bellgossett.com/#sle.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
   C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:
1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.02 STRAINERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.03 COMBINATION FLOW CONTROLS

A. Manufacturers:
2. ITT Bell & Gossett: www.bellgossett.com/#sle.
3. Tour & Anderson: www.tahydronics.com
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.04 RELIEF VALVES

A. Manufacturers:
2. ITT Bell & Gossett: www.bellgossett.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.
B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
C. Provide manual air vents at system high points and as indicated.
D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
E. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
F. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
G. Support pump fittings with floor mounted pipe and flange supports.
H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
J. Pipe relief valve outlet to nearest floor drain.
K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION
SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Metal ductwork.
   B. Casing and plenums.

1.02 RELATED REQUIREMENTS
   A. Section 03 30 00 - Cast-in-Place Concrete.
   B. Section 09 91 13 - Exterior Painting: Weld priming, weather resistant, paint or coating.
   C. Section 11 40 00 - Foodservice Equipment: Supply of kitchen range hoods for placement by this Section.
   D. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
   E. Section 23 33 00 - Air Duct Accessories.
   F. Section 23 36 00 - Air Terminal Units.
   G. Section 23 37 00 - Air Outlets and Inlets.
   H. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS
   C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   J. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, Culvert Pipe and (Metric).
1.04 PERFORMANCE REQUIREMENTS
A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for duct materials and duct connections.
C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems.
D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
E. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.
F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.07 REGULATORY REQUIREMENTS
A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.08 FIELD CONDITIONS
A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES
2.02 ALL DUCT ASSEMBLIES SHALL BE FABRICATED TO ACHIEVE A MAXIMUM OF 1% DUCT LEAKAGE. DUCT SHALL BE FIELD TESTED BY SHEET METAL CONTRACTOR AND WITNESSED BY THE BALANCER.
A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
2.03 MATERIALS

A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.


C. Stainless Steel for Ducts: ASTM A666, Type 304.

D. Flexible Ducts:
   1. Two UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
      a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
      b. Maximum Velocity: 4000 fpm.
      c. Temperature range: -20 F to 160 F

E. Insulated Flexible Ducts:
   1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
      a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
      b. Maximum Velocity: 4000 fpm.
      c. Temperature Range: -10 degrees F to 160 degrees F.
      d. Thermal resistance 4.2 square feet-hour-degree F per BTU

F. Ducts: Galvanized steel, unless otherwise indicated.

G. Low Pressure Supply (Heating Systems): 1/2 inch w.g. pressure class, galvanized steel.

H. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.

I. Buried Supply, Return, Intake, or Relief: 1/2 inch w.g. pressure class, concrete encased sheet metal.
   1. Fabricate using two gages heavier material than indicated for 2 inch w.g. pressure class.

J. Return and Relief: 1/2 inch w.g. pressure class, galvanized steel.

K. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.

L. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.

M. Hanger Rod: ASTM A 36/A 36M; steel; threaded both ends, threaded one end, or continuously threaded.

2.04 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.

C. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

D. Construct T’s, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide turning vanes.
E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

G. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

H. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

I. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.05 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Double Wall Insulated Round Ducts: Round spiral lockseam duct with paintable galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall. Provide paint in color selected by architect.
   1. Manufacture in accordance with SMACNA (DCS).
   2. Insulation:
      a. Thickness: 1 inch.
      b. Material: Fiberglass, with mylar coating between insulation and perforated liner.

C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).

2.06 CASINGS

A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

C. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.

D. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
   1. Provide clear wire glass observation ports, minimum 6 by 6 inch size.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. Buried Metal Ductwork: Paint according to SMACNA (DCS).
D. Buried Metal Ductwork Without Factory Jacket: Paint with one coat and seams and joints with additional coat of asphalt base protective coating.

E. Buried Metal Ductwork: Encase according to SMACNA (DCS).
   1. Provide adequate tie-down points to prevent ducts from floating during concrete placement.
   2. Introduce no heat into ducts for 20 days following placement of concrete.

F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

G. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

H. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

J. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

K. Use double nuts and lock washers on threaded rod supports.

L. Tape joints of PVC coated metal ductwork with PVC tape.

M. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

N. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

O. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

P. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

Q. Use stainless steel for ductwork exposed to view and stainless steel or carbon steel for ducts where concealed.

R. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

S. At exterior wall louvers, seal duct to louver frame and install blank-out panels as required.

3.02 CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.03 SCHEDULES

A. Ductwork Material:
   2. Low Pressure Supply (System with Cooling Coils): Steel, Aluminum.
   3. Return and Relief: Steel, Aluminum.
6. Outside Air Intake: Steel.
7. Exposed round ductwork: Double-walled spiral.

B. Ductwork Pressure Class:
1. Supply (Heating Systems): 1 inch
2. Supply (System with Cooling Coils): 2 inch.
3. Return and Relief: 1 inch.
4. General Exhaust: 1 inch.
5. Outside Air Intake: 1 inch.

END OF SECTION
SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Air turning devices/extractors.
B. Backdraft dampers.
C. Duct access doors.
D. Duct test holes.
E. Flexible duct connections.
F. Volume control dampers.

1.02 RELATED REQUIREMENTS
A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.
C. Section 23 36 00 - Air Terminal Units: Pressure regulating damper assemblies.
D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.
F. UL 555 - Standard for Fire Dampers.
G. UL 555S - Standard for Smoke Dampers.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.

1.05 PROJECT RECORD DOCUMENTS
A. Record actual locations of access doors and test holes.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Protect dampers from damage to operating linkages and blades.
1.08 EXTRA MATERIALS
   A. See Section 01 6000 - Product Requirements, for additional provisions.
   B. Provide two of each size and type of fusible link.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
   C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 DUCT ACCESS DOORS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
   C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
      1. Less Than 12 inches Square: Secure with sash locks.
      2. Up to 18 inches Square: Provide two hinges and two sash locks.
      3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
      4. Larger Sizes: Provide an additional hinge.
   D. Access doors with sheet metal screw fasteners are not acceptable.

2.04 DUCT TEST HOLES
   A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
   B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
2.05 FLEXIBLE DUCT CONNECTIONS
   A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
   B. Flexible Duct Connections: Fabric crimped into metal edging strip.
      1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A,
         minimum density 30 oz per sq yd.
      2. Metal: 3 inches wide, 24 gage thick galvanized steel.
   C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to
      10,000 Hz range.

2.06 VOLUME CONTROL DAMPERS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
   C. Splitter Dampers:
      1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier
         for sizes over 24 inches.
      2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with
         continuous hinge or rod.
      3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged
         bushing with set screw.
   D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
   E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72
      inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame
      with suitable hardware.
   F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple
      blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
   G. Quadrants:
      1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
      2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or
         adapters.

PART 3 EXECUTION

3.01 PREPARATION
   A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION
   A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow
      SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 00 for duct construction
      and pressure class.
   B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where
      indicated.
   C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans,
      automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as
      indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide
minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
   1. Smoke dampers shall be integrated into the "smoke purge control system". Dampers in the return ductwork shall be overridden to the open position when the smoke purge is activated.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment; see Section 22 05 48.

J. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.

K. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

L. Use splitter dampers only where indicated.

M. Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 00 - Air Terminal Units.

N. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION
SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Wall exhausters.

1.02 RELATED REQUIREMENTS
A. Section 23 05 13 - Motor Requirements for HVAC and Plumbing Equip.
B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS
A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans.
E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
D. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
E. Twin City Fan & Blower: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL
A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
D. Fabrication: Conform to AMCA 99.
E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 WALL EXHAUSTERS
A. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch mesh, 0.062 inch thick aluminum wire bird screen.
B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
C. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION
SECTION 23 37 00
AIR OUTLETs AND INLETs

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Registers/grilles.
   B. Critical environment diffusers.

1.02 RELATED REQUIREMENTS
   A. Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS
   A. AHRI 880 (I-P) - Performance Rating of Air Terminals.
   B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
   C. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute.
   D. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets.
   J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
   C. Samples: Submit two of each required air outlet and inlet type.
   D. Project Record Documents: Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE
   A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
   B. Test and rate louver performance in accordance with AMCA 500-L.

1.06 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

1.07 MOCK-UP
   A. Provide mock-up of typical exterior or exterior ceiling module with supply and return air outlets.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS
D. Metal Aire: www.metalaire.com
E. Nailor Industries: nailor.com
F. Tuttle and Bailey: www.tuttleandbailey.com/#sle.
G. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORATED FACE CEILING DIFFUSERS
A. Type: Perforated face with fully adjustable pattern and removable face.
B. Frame: Surface mount or Inverted T-bar as indicated on drawings. In plaster ceilings, provide plaster frame and ceiling frame.
C. Fabrication: Steel with steel or aluminum frame and baked enamel off-white finish.
D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 CEILING EXHAUST AND RETURN REGISTERS/GRILLES
A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
B. Frame: 1-1/4 inch margin with countersunk screw mounting.
C. Fabrication: Aluminum extrusions, with factory off-white enamel, baked enamel, or prime coated finish as indicated on drawings or selected by architect.
D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.04 CRITICAL ENVIRONMENTS DIFFUSERS
A. General Requirements:
   1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
B. Laminar Flow Diffusers:
   2. Frame: Provide framing per manufacturer's recommendations.
   3. Dimensions: As indicated.
   4. Damper: Provide volume control per manufacturer's recommendations.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
C. Install diffusers to ductwork with air tight connection.
D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 23.
3.02 AIR OUTLET AND INLET SCHEDULE

A. See Drawings

END OF SECTION
SECTION 23 82 16
AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Water heating coils.

1.02 RELATED REQUIREMENTS
A. Section 23 07 19 - HVAC Piping Insulation.
B. Section 23 21 14 - Hydronic Specialties.
C. Section 23 31 00 - HVAC Ducts and Casings: Installation of duct coils.

1.03 REFERENCE STANDARDS
B. NFPA 70 - National Electrical Code.
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
D. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
B. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. JCI: www.jci.com
B. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 WATER HEATING COILS
A. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
B. Fins: Aluminum or copper continuous plate type with full fin collars.
C. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

D. Headers: Cast iron with tubes expanded into header.

E. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.

F. Configuration: Drainable, with threaded plugs for drain and vent.

G. Fin Spacing: 8 fins per inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturers written instructions.

B. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

C. Hydronic Coils:
   1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
   2. Provide manual air vents at high points complete with stop valve.
   3. Ensure water coils are drainable and provide drain connection at low points.
   4. Refer to Section 23 21 14.

END OF SECTION
SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Electrical demolition.

1.02 RELATED REQUIREMENTS
   A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT
   A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify field measurements and circuiting arrangements are as indicated.
   B. Verify that abandoned wiring and equipment serve only abandoned facilities.
   C. Demolition drawings are based on casual field observation and existing record documents.
   D. Report discrepancies to Owner before disturbing existing installation.
   E. Report discrepancies to Architect before disturbing existing installation.
   F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION
   A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
   B. Coordinate utility service outages with utility company.
   C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
   D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
      2. Make temporary connections to maintain service in areas adjacent to work area.
   E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Notify Owner before partially or completely disabling system.
      2. Notify local fire service.
      3. Make notifications at least 24 hours in advance.
      4. Make temporary connections to maintain service in areas adjacent to work area.
   F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Notify Owner at least 24 hours before partially or completely disabling system.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
   A. Remove, relocate, and extend existing installations to accommodate new construction.
B. Remove abandoned wiring to source of supply.
C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
G. Repair adjacent construction and finishes damaged during demolition and extension work.
H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
I. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR
A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
B. Clean and repair existing materials and equipment that remain or that are to be reused.
C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Single conductor building wire.
B. Metal-clad cable.
C. Wiring connectors.
D. Electrical tape.
E. Heat shrink tubing.
F. Wire pulling lubricant.
G. Cable ties.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS
A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
G. NECA 1 - Standard for Good Workmanship in Electrical Construction.
H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC).
K. NFPA 70 - National Electrical Code.
L. UL 44 - Thermoset-Insulated Wires and Cables.
M. UL 83 - Thermostatic-Insulated Wires and Cables.
N. UL 486A-486B - Wire Connectors.
O. UL 486C - Splicing Wire Connectors.
P. UL 486D - Sealed Wire Connector Systems.
Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
R. UL 1569 - Metal-Clad Cables.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
C. 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.
D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Manufactured Wiring Systems Cable Assemblies: One of each configuration, 6 feet length.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS
A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.
PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

H. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

I. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
   2. Control Circuits: 14 AWG.

J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

K. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
3) Phase C: Blue.
4) Neutral/Grounded: White.
c. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE
A. Manufacturers:
   1. Copper Building Wire:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
B. Description: Single conductor insulated wire.
C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      b. Size 8 AWG and Larger: Stranded.
D. Insulation Voltage Rating: 600 V.
E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.

2.04 METAL-CLAD CABLE
A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.
D. Insulation Voltage Rating: 600 V.
E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
G. Grounding: Full-size integral equipment grounding conductor.
H. Armor: Steel, interlocked tape.
I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.05 WIRING CONNECTORS
A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors Ploaris electrical connectors, IT series or IPL series.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   3. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      c. NSI Industries LLC: www.nsiindustries.com/#sle.
      d. Ploaris Electrical Connectors.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.06 WIRING ACCESSORIES

A. Electrical Tape:
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2. Vinyl Color Coding Electrical Tape: Integrially colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Cable Ties: Plenum rated, material and tensile strength rating suitable for application.
   1. Manufacturers:
      b. Thomas & Betts.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1.Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
   6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install metal-clad cable (Type MC) in accordance with NECA 120.
E. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Exposed Cable Installation (only where specifically permitted):
   1. Route cables parallel or perpendicular to building structural members and surfaces.
   2. Protect cables from physical damage.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

I. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Install conductors with a minimum of 12 inches of slack at each outlet.

K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

M. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
   a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
   b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

O. Insulate ends of spare conductors using vinyl insulating electrical tape.

P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect and test in accordance with NETA ATS, except Section 4.
   C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
   D. Correct deficiencies and replace damaged or defective conductors and cables.

   END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Ground bars.
E. Ground rod electrodes.
F. Grounding and bonding components.
G. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Existing metal underground water pipe.
   2. Metal frame of the building.
   3. Concrete-encased electrode.
   4. Existing metal underground gas piping system.
   5. Rod electrodes.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NFPA 70 - National Electrical Code.
D. UL 467 - Grounding and Bonding Equipment.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 5 ohms.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
B. Shop Drawings:
   1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
C. Product Data: Provide for grounding electrodes and connections.
D. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
E. Manufacturer's 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.
F. Project Record Documents: Record actual locations of grounding electrode system components and connections.
G. Project Record Documents: Record actual locations of components and grounding electrodes.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS
A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
D. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
      b. Metal gas piping.
      c. Metal process piping.
   8. Provide bonding for interior metal air ducts.

2.02 GROUNDING AND BONDING COMPONENTS
A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
   4. Manufacturers - Mechanical and Compression Connectors:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.

2.03 MANUFACTURERS
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 CONNECTORS AND ACCESSORIES
   A. Mechanical Connectors: Bronze.
      1. Product: Type GG/GGH manufactured by Blackburn.
   B. Wire: Stranded copper.
   C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that work likely to damage grounding and bonding system components has been completed.
   B. Verify that field measurements are as indicated.
   C. Verify that conditions are satisfactory for installation prior to starting work.
   D. Verify existing conditions prior to beginning work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
C. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without
      cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate
      insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and
      contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the
      items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended
      torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools
      and dies.

D. Identify grounding and bonding system components in accordance with Section 26 05 53.

E. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing
   Bond steel together.

F. Provide bonding to meet requirements described in Quality Assurance.

G. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder
   and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

### 3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Owner will provide field inspection in accordance with Section 01 4000.

C. Perform inspection in accordance with Section 01 40 00.

D. Inspect and test in accordance with NETA ATS except Section 4.

E. Perform inspections and tests listed in NETA ATS, Section 7.13.

F. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the
   previous 48 hours does not constitute normally dry conditions.

G. Investigate and correct deficiencies where measured ground resistances do not comply with
   specified requirements.

**END OF SECTION**
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 REFERENCE STANDARDS

D. MFMA-4 - Metal Framing Standards Publication.
F. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements
G. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements
I. NECA 1 - Standard for Good Workmanship in Electrical Construction.
J. NFPA 70 - National Electrical Code.
K. UL 5B - Strut-Type Channel Raceways and Fittings.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
C. Product Data: Provide manufacturer's catalog data for fastening systems.
D. Manufacturer's 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.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with applicable building code.
C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
   3. Manufacturers:
      e. Substitutions: See Section 01 60 00 - Product Requirements.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:
e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
3. Channel Material:
4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
6. Manufacturers:
   c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
   d. Substitutions: See Section 01 60 00 - Product Requirements.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
   c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
   d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
   e. Outlet Boxes: 1/4 inch diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
5. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   b. Channel Material: Use galvanized steel.
   c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

2.02 MANUFACTURERS

2.03 MATERIALS
A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
B. Supports: Fabricated of structural steel or formed steel members; galvanized.
C. Anchors and Fasteners:
   1. Obtain permission from Architect before using powder-actuated anchors.
   2. Concrete Structural Elements: Use precast inserts, expansion anchors, powder-actuated anchors, or preset inserts.
   3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
   4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
7. Sheet Metal: Use sheet metal screws.

D. Fastener Types:
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
6. Other Types: As required.
7. Manufacturers:
   b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Formed Steel Channel:
1. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
H. Conduit Support and Attachment: Also comply with Section 26 05 33.13.
I. Box Support and Attachment: Also comply with Section 26 05 33.16.
J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
K. Secure fasteners according to manufacturer's recommended torque settings.
L. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect support and attachment components for damage and defects.
C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Galvanized steel rigid metal conduit (RMC).
B. Flexible metal conduit (FMC).
C. Liquidtight flexible metal conduit (LFMC).
D. Electrical metallic tubing (EMT).
E. Conduit fittings.
F. Accessories.
G. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.
D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
E. Section 26 05 33.16 - Boxes for Electrical Systems.
F. Section 26 05 33.23 - Surface Raceways for Electrical Systems.
G. Section 26 0553 - Identification for Electrical Systems.
H. Section 26 05 33.16 - Boxes for Electrical Systems.
I. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
J. Section 26 21 00 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

1.03 REFERENCE STANDARDS
A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC).
E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
H. NFPA 70 - National Electrical Code.
I. UL 1 - Flexible Metal Conduit.
J. UL 360 - Liquid-Tight Flexible Steel Conduit.
K. UL 514B - Conduit, Tubing, and Cable Fittings.
L. UL 797 - Electrical Metallic Tubing-Steel.
M. UL 1242 - Electrical Intermediate Metal Conduit-Steel.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
C. Shop Drawings:
1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
2. Include proposed locations of roof penetrations and proposed methods for sealing.
D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.
E. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.
F. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
B. Accept conduit on site. Inspect for damage.
C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

E. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

G. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet unless otherwise indicated.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits: Also comply with Section 26 21 00.

C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

E. Provide products listed, classified, and labeled as suitable for the purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 METAL CONDUIT

A. Manufacturers:
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.
C. Rigid Aluminum Conduit: ANSI C80.5.
D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

D. Description: Interlocked steel construction.
E. Fittings: NEMA FB 1.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
1. Manufacturers:
   d. Substitutions: See Section 01 60 00 - Product Requirements.

   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

   3. Material: Use steel or malleable iron.

D. Description: Interlocked steel construction with PVC jacket.
E. Fittings: NEMA FB 1.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
6. Substitutions: See Section 01 60 00 - Product Requirements.
B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
   4. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.
   5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
   6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.08 ACCESSORIES
A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
B. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive conduits.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify routing and termination locations of conduit prior to rough-in.
E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
E. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal all conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
F. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
4. Use conduit clamp to support single conduit from beam clamp or threaded rod.
5. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
6. Use of wire for support of conduits is not permitted.

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

I. Underground Installation:
1. Provide trenching and backfilling in accordance with Sections 31 2316 and 31 2323.
2. Minimum Cover, Unless Otherwise Indicated or Required:
3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.
K. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
   1. Where conduits pass from outdoors into conditioned interior spaces.
   2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

L. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

M. Provide grounding and bonding in accordance with Section 26 05 26.

N. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
   C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING
   A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION
   A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION
SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Underground boxes/enclosures.
D. Wall and ceiling outlet boxes.
E. Pull and junction boxes.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 05 33.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.
   2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
G. Section 26 2716 - Electrical Cabinets and Enclosures.

1.03 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
F. NFPA 70 - National Electrical Code.
G. SCTE 77 - Specification for Underground Enclosure Integrity.
H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
J. UL 508A - Industrial Control Panels.
K. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
   1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
C. 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.
D. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 BOXES
A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use “through-wall” boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
13. Manufacturers:
   b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
   e. Substitutions: See Section 01 60 00 - Product Requirements.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   a. Indoor Clean, Dry Locations: Type 1, painted steel.
   b. Outdoor Locations: Type 3R, painted steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches:
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

D. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Applications:
   a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
   b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 15 load rating.
   c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
5. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
   a. Manufacturers:
2) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.

b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

2.02 MANUFACTURERS
B. Arc-Co./Division of Arcade Technology: www.arc-co.com.

2.03 OUTLET BOXES
A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required. Single gang box to have 15.6 cubic inches and double gang boxes to have 30.3 cubic inches capacity.
   2. Concrete Ceiling Boxes: Concrete type.
B. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
C. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.04 PULL AND JUNCTION BOXES
A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
B. Hinged Enclosures: As specified in Section 26 2716.
C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide separate boxes for emergency power and normal power systems.
E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
F. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
   2. Unless dimensioned, box locations indicated are approximate.
3. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.

G. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

H. Install boxes plumb and level.

I. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

J. Install boxes as required to preserve insulation integrity.

K. Underground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches deep.
   2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide grounding and bonding in accordance with Section 26 05 26.

Q. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.

R. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

S. Maintain headroom and present neat mechanical appearance.

T. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

U. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

V. Use gang box where more than one device is mounted together. Do not use sectional box.

3.03 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.
3.04 CLEANING
   A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.05 PROTECTION
   A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION
SECTION 26 05 33.23
SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface raceway systems.

1.02 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 33.13 - Conduit for Electrical Systems.
D. Section 26 05 33.16 - Boxes for Electrical Systems.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 27 26 - Wiring Devices: Receptacles.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NFPA 70 - National Electrical Code.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
D. UL 5 - Surface Metal Raceways and Fittings.
E. UL 111 - Outline of Investigation for Multioutlet Assemblies.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 and conduit provided under Section 26 05 33.13 as required for installation of raceways provided under this section.
   3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install raceways until final surface finishes and painting are complete.
   2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
   1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS
2.01 RACEWAY REQUIREMENTS
   A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
   B. Provide products listed, classified, and labeled as suitable for the purpose intended.
   C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.02 SURFACE RACEWAY SYSTEMS
   A. Manufacturers:
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
   C. Multioutlet Assemblies: Listed and labeled as complying with UL 111.

2.03 SOURCE QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
   C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Install raceways plumb and level.
   D. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
   E. Secure and support raceways in accordance with Section 26 05 29 at intervals complying with NFPA 70 and manufacturer's requirements.
   F. Close unused raceway openings.
   G. Provide grounding and bonding in accordance with Section 26 05 26.
   H. Identify raceways in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect raceways for damage and defects.
   C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.
D. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING
   A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 PROTECTION
   A. Protect installed raceways from subsequent construction operations.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Voltage markers.
E. Warning signs and labels.
F. Field-painted identification of conduit.

1.02 REFERENCE STANDARDS
D. NFPA 70 - National Electrical Code.
E. UL 969 - Marking and Labeling Systems.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
D. Product Data: Provide catalog data for nameplates, labels, and markers.
E. Manufacturer's 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.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.06 FIELD CONDITIONS
A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS
A. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   a. Panelboards:
      1) Identify ampere rating.
      2) Identify voltage and phase.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
      4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
      5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
      6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
   b. Transformers:
      1) Identify kVA rating.
      2) Identify voltage and phase for primary and secondary.
      3) Identify power source and circuit number. Include location when not within sight of equipment.
   c. Enclosed switches, circuit breakers, and motor controllers:
      1) Identify voltage and phase.
      2) Identify power source and circuit number. Include location when not within sight of equipment.

2. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

3. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

4. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.

5. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.

6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

7. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.

8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

9. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
   a. Service equipment.
   b. Industrial control panels.
   c. Motor control centers.
   d. Elevator control panels.
   e. Industrial machinery.

10. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
11. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

12. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
   a. At each source and load connection.
   b. Within boxes when more than one circuit is present.

C. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
4. Use underground warning tape to identify underground raceways.
5. Use warning labels to identify electrical hazards for cable tray containing conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP AWAY" at maximum intervals of 10 feet.
6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
2. Use voltage markers or color coded boxes to identify systems other than normal power system.
   a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the same color code used for raceways.

E. Identification for Devices:
1. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
   a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.

F. Communication Cabinets: Nameplates.

G. Conduit: Conduit markers.

H. Control Device Station: Labels.

I. Electrical Distribution and Control Equipment Enclosures: Nameplates.

J. Junction Box Load Connections: Wire markers.


L. Pull Box Load Connections: Wire markers.
2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Manufacturers:
   d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Materials:
   a. Indoor Clean, Dry Locations: Use plastic nameplates.
   b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Manufacturers:
   d. Substitutions: See Section 01 60 00 - Product Requirements.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
   a. System designation where applicable:
      1) Emergency Power System: Identify with text "EMERGENCY".
      2) Fire Alarm System: Identify with text "FIRE ALARM".
   b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
   a. System Designation: 1 inch.
   b. Equipment Designation: 1/2 inch.
   c. Other Information: 1/4 inch.
   d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:

D. Manufacturers:
3. Or Equal.
2.03 WIRE AND CABLE MARKERS

A. Manufacturers:
   4. Or Equal.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

H. Description: Vinyl cloth type self-adhesive wire markers.

I. Color: Black on white.

J. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2.04 VOLTAGE MARKERS

A. Manufacturers:
   4. Or Equal.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

E. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
2. Markers for System Identification:
   a. Emergency Power System: Text "EMERGENCY".
F. Color: Black text on orange background unless otherwise indicated.
G. Description: Cloth type conduit markers.
H. Location: Furnish markers for each conduit longer than 6 feet.
I. Spacing: 20 feet on center.

2.05 WARNING SIGNS AND LABELS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
C. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.
D. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION
3.01 PREPARATION
   A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
      3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
      4. Elevated Equipment: Legible from the floor or working platform.
      5. Branch Devices: Adjacent to device.
      6. Interior Components: Legible from the point of access.
      7. Conduits: Legible from the floor.
      8. Boxes: Outside face of cover.
      9. Conductors and Cables: Legible from the point of access.
     10. Devices: Outside face of cover.
   C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Secure rigid signs using stainless steel screws.

G. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION
SECTION 26 05 83
WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 26 05 33.13 - Conduit for Electrical Systems.
C. Section 26 05 33.16 - Boxes for Electrical Systems.
D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCE STANDARDS
A. NEMA WD 1 - General Color Requirements for Wiring Devices.
B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
C. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and
      manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions,
   configurations, and construction.
C. Manufacturer's 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.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a
   Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having
   jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS
A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for
   equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified
      equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit
      overcurrent protection.
B. Wiring Devices: As specified in Section 26 27 26.
C. Wire and Cable: As specified in Section 26 05 19.
D. Boxes: As specified in Section 26 05 33.16.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.
B. Provide receptacle outlet to accommodate connection with attachment plug.
C. Provide cord and cap where field-supplied attachment plug is required.
D. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

END OF SECTION
SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Occupancy sensors.
   B. Daylighting controls.
   C. Control accessories.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   C. Section 26 05 33.16 - Boxes for Electrical Systems.
   D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   E. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
      1. Includes accessory receptacles, switches, dimmers and wall plates, to match lighting controls specified in this section.
   F. Section 26 28 13 - Fuses.
   G. Section 26 51 00 - Interior Lighting.

1.03 REFERENCE STANDARDS
   C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
   E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   F. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
      2. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
      3. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
      4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
   B. Sequencing:

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

C. Shop Drawings:

D. Field Quality Control Reports.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all occupancy sensors.

C. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.01 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.02 OCCUPANCY SENSORS

A. Manufacturers:
   3. DLM
   4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. All Occupancy Sensors:
1. **Description:** Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.

2. **Sensor Technology:**
   a. **Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors:** Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.

3. **Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.**

4. **Operation:** Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

5. **Dual Technology Occupancy Sensors:** Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.

6. **Turn-Off Delay:** Field adjustable, with time delay settings up to 30 minutes.

7. **Sensitivity:** Field adjustable.

8. **Compatibility (Non-Dimming Sensors):** Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.

9. **Load Rating for Line Voltage Occupancy Sensors:** As required to control the load indicated on drawings.

### 2.03 DAYLIGHTING CONTROLS

A. **Manufacturers:**

B. **System Description:** Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

C. **Daylighting Control Photo Sensors:** Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
   1. **Sensor Type:** Filtered silicon photo diode.
   2. **Sensor Range:**
      a. **Indoor Photo Sensors:** 5 to 100 footcandles.
   3. **Finish:** White unless otherwise indicated.
   4. **Wireless Daylighting Control Photo Sensors:**
      a. **RF Range:** 30 feet through typical construction materials.
      b. **Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits:** Comply with FCC requirements of 47 CFR 15, for Class B application.
      c. **Power:** Battery-operated with minimum ten-year battery life.

D. **Daylighting Control Switching Modules for Wireless Sensors:**
   1. **Description:** Plenum rated, self-contained relay compatible with specified wireless photo sensors for switching of line voltage loads in response to changes in measured light levels according to selected settings.
2. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
3. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
4. Control Capability: Capable of controlling one programmable channel.
5. Input Supply Voltage: Dual rated for 120/277 V ac.

E. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
2. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
3. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
4. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.

F. Daylighting Control Dimming Modules for Wireless Sensors:
1. Description: Plenum rated control unit compatible with specified wireless photo sensors and with specified dimming ballasts, for continuous dimming of compatible dimming ballasts in response to changes in measured light levels according to selected settings.
2. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
3. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.
4. Control Capability: Capable of controlling up to 32 ballasts with up to two separately programmable daylighting zones.

G. Power Packs for Low Voltage Daylighting Control Modules:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
2. Input Supply Voltage: Dual rated for 120/277 V ac.

H. Accessories:
1. Where indicated, provide compatible accessory wall switches for manual override control.
2. Where indicated, provide compatible accessory wireless controls for manual override control.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each lighting contactor, minimum.

B. Pilot Devices:
1. Comply with NEMA ICS 5; heavy-duty type.
2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
   C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
   D. Verify that final surface finishes are complete, including painting.
   E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
   F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
   G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Provide extension rings to bring outlet boxes flush with finished surface.
   B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
   A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
   B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of lighting control devices provided under this section.
   C. Install lighting control devices in accordance with manufacturer’s instructions.
   D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   E. Install lighting control devices plumb and level, and held securely in place.
   F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.
   G. Provide required supports in accordance with Section 26 05 29.
   H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
   I. Identify lighting control devices in accordance with Section 26 05 53.
   J. Occupancy Sensor Locations:
      1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
K. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
   2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
   3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

L. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect each lighting control device for damage and defects.
   C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
   D. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
   E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.05 ADJUSTING
   A. Adjust devices and wall plates to be flush and level.
   B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
   C. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.06 CLEANING
   A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING
   A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
   C. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
      1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION
SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS
A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NECA 407 - Standard for Installing and Maintaining Panelboards.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
F. NEMA PB 1 - Panelboards.
G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
I. NFPA 70 - National Electrical Code.
J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
L. UL 67 - Panelboards.
M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
      1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated 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. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
   F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
   G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
   C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
   B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
   A. Maintain ambient temperature within the following limits during and after installation of panelboards:
      1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
   D. Substitutions: See Section 01 60 00 - Product Requirements.
E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
   3. Label equipment utilizing series ratings as required by NFPA 70.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. All phase, neutral, and ground busses shall be copper.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
   3. Fronts:
      a. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:
   1. Siemens.
   2. Eaton Cutler Hammer E.
   3. Schneider Electric E.

C. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

D. Bussing:
1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

E. Circuit Breakers:
1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

F. Enclosures:
1. Provide flush-mounted enclosures unless otherwise indicated.
2. Fronts: Provide door-in-door trim with lockable hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide metal circuit directory holder mounted on inside of door.

G. Manufacturers: SQ D or equal

H. Description: NEMA PB 1, circuit breaker type.

I. Service Conditions:
1. Altitude: 1000 ft
2. Temperature: 70 deg F.

J. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.

K. Minimum integrated short circuit rating: As indicated.

L. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

M. Enclosure: NEMA PB 1, Type 1, 6.5 in deep, ide, cabinet box.

N. Cabinet Front: Surface type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:
1. Siemens.
2. Eaton Cutler Hammer.
3. Schneider Electric.

C. Conductor Terminations:
1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
2. Main and Neutral Lug Type: Mechanical.

D. Bussing:
2. Phase and Neutral Bus Material: Copper.

E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

F. Enclosures:
1. Provide flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with lockable hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide metal circuit directory holder mounted on inside of door.

G. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

H. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

I. Minimum Integrated Short Circuit Rating: As indicated.

J. Enclosure: NEMA PB 1, Type 1.

K. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

L. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
      2) 21000 rms symmetrical amperes at 480 VAC.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Lug Material: Copper, suitable for terminating copper conductors only.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   b. Provide interchangeable trip units where indicated.

5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

6. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

7. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.

8. Do not use tandem circuit breakers.

9. Do not use handle ties in lieu of multi-pole circuit breakers.

10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

2.06 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
E. Provide required supports in accordance with Section 26 05 29.
F. Install panelboards plumb.
G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
J. Provide grounding and bonding in accordance with Section 26 05 26.
K. Install all field-installed branch devices, components, and accessories.
L. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
M. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
N. Provide filler plates to cover unused spaces in panelboards.
O. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Fire detection and alarm circuits.
P. Identify panelboards in accordance with Section 26 05 53.
Q. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
R. Ground and bond panelboard enclosure according to Section 26 0526.

3.03 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Correct deficiencies and replace damaged or defective panelboards or associated components.
E. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.
3.04 ADJUSTING
   A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
   B. Adjust alignment of panelboard fronts.
   C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING
   A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
   B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 27 26
WIRING DEVICES

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Wall switches.
B. Wall dimmers.
C. Receptacles.
D. Wall plates.

1.02  RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 0535 - Surface Raceways: Surface raceway systems, including multioutlet assemblies.
D. Section 26 05 33.16 - Boxes for Electrical Systems.
E. Section 26 05 33.23 - Surface Raceways for Electrical Systems: Surface raceway systems, including multioutlet assemblies.
F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03  REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
D. NEMA WD 1 - General Color Requirements for Wiring Devices.
E. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
F. NFPA 70 - National Electrical Code.
G. UL 498 - Attachment Plugs and Receptacles.
H. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
I. UL 943 - Ground-Fault Circuit-Interrupters.
J. UL 1472 - Solid-State Dimming Controls.

1.04  ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
   4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
C. 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.
D. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.
E. Project Record Documents: Record actual installed locations of wiring devices.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Wall Plates: One of each style, size, and finish.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Products: Listed, classified, and labeled as suitable for the purpose intended.
E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS
2.01 MANUFACTURERS
C. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
D. Substitutions: See Section 01 60 00 - Product Requirements.
E. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

2.02 WIRING DEVICE APPLICATIONS
A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
2.03 WIRING DEVICE FINISHES
   A. Provide wiring device finishes as described below unless otherwise indicated.
   B. Wiring Devices, Unless Otherwise Indicated: Black with stainless steel wall plate.
   C. Wiring Devices Installed in Finished Spaces: Black with stainless steel wall plate.

2.04 WALL SWITCHES
   A. Manufacturers:
      3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.05 WALL DIMMERS
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
   C. Control: Slide control type with separate on/off switch.
   D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
      1. LED drivers 1000 watts
   E. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.06 RECEPTACLES
   A. Manufacturers:
      3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
      1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
      2. NEMA configurations specified are according to NEMA WD 6.
   C. Convenience Receptacles:
      1. Standard Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
   D. GFCI Receptacles:
1. **GFCI Receptacles - General Requirements:** Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
   a. Provide test and reset buttons of same color as device.
2. **Standard GFCI Receptacles:** Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

**E. Locking Receptacles:** Industrial specification grade, configuration as indicated on the drawings.
1. **Standard Locking Convenience Receptacles:** Single, 20A, 125V, NEMA L5-20R.
2. **Locking Receptacles for equipment:** Single 20A, 250V, NEMA L6-20R.
3. **Locking Receptacles for equipment:** Single 30A, 250V, NEMA L6-30R.

### 2.07 WALL PLATES

**A. Manufacturers:**
4. Substitutions: See Section 01 60 00 - Product Requirements.
5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

**B. Wall Plates:** Comply with UL 514D.
1. **Configuration:** One piece cover as required for quantity and types of corresponding wiring devices.
2. **Size:** Standard.
3. **Screws:** Metal with slotted heads finished to match wall plate finish.

**C. Stainless Steel Wall Plates:** Brushed satin finish, Type 302 stainless steel.

### PART 3 EXECUTION

#### 3.01 EXAMINATION

**A.** Verify that field measurements are as indicated.

**B.** Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

**C.** Verify that wall openings are neatly cut and will be completely covered by wall plates.

**D.** Verify that final surface finishes are complete, including painting.

**E.** Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

**F.** Verify that conditions are satisfactory for installation prior to starting work.

#### 3.02 PREPARATION

**A.** Provide extension rings to bring outlet boxes flush with finished surface.

**B.** Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

#### 3.03 INSTALLATION

**A.** Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

**B.** Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.

1. **Mounting Heights:** Unless otherwise indicated, as follows:
   a. **Wall Switches:** 48 inches above finished floor.
   b. **Wall Dimmers:** 48 inches above finished floor.
c. Receptacles: 18 inches above finished floor or 6 inches above counter.
2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
3. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

C. Install wiring devices in accordance with manufacturer’s instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Install wiring devices plumb and level with mounting yoke held rigidly in place.

I. Install wall switches with OFF position down.

J. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

K. Do not share neutral conductor on branch circuits utilizing wall dimmers.

L. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

M. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

O. Identify wiring devices in accordance with Section 26 05 53.

### 3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer’s instructions.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

### 3.05 ADJUSTING

A. Adjust devices and wall plates to be flush and level.
3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fuses.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   B. Section 26 28 16.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS
   A. NEMA FU 1 - Low Voltage Cartridge Fuses.
   B. NFPA 70 - National Electrical Code.
   D. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
      3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com/#sle.
   C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS
   A. Feeders:
      1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.

2.03 FUSES
   A. Provide products listed, classified, and labeled as suitable for the purpose intended.
   B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
C. Provide fuses of the same type, rating, and manufacturer within the same switch.
D. Comply with UL 248-1.
E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
F. Voltage Rating: Suitable for circuit voltage.
G. Class R Fuses: Comply with UL 248-12.
   1. Class RK1, Time-Delay Fuses:
      a. Products:
         1) Cooper Bussmann : LPN-RK-100 SP.
         2) Ferraz Shawmut : A2D100 R.
         3) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Do not install fuses until circuits are ready to be energized.
B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION
SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
E. Section 26 28 13 - Fuses.
F. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.03 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
E. NFPA 70 - National Electrical Code.
F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
H. UL 98 - Enclosed and Dead-Front Switches.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
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. Project Record Documents: Record actual locations of enclosed switches.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Eaton Corporation; ______: www.eaton.com/#sle.
C. Schneider Electric; Square D Products; ______: www.schneider-electric.us/#sle.
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ENCLOSED SAFETY SWITCHES
A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
D. Horsepower Rating: Suitable for connected load.
E. Voltage Rating: Suitable for circuit voltage.
F. Short Circuit Current Rating:
   1. Minimum Ratings:
      a. Heavy Duty Single Throw Switches Protected by Class R Fuses: 200,000 rms symmetrical amperes.
G. Provide with switch blade contact position that is visible when the cover is open.
H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

M. Heavy Duty Switches:
   1. Products:
      a. Eaton Corporation.
      b. General Electric Company.
      c. Schneider Electric; SQ D products.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Comply with NEMA KS 1.
   3. Conductor Terminations:
      a. Lug Material: Copper, suitable for terminating copper conductors only.
   4. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive enclosed safety switches.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   D. Provide required supports in accordance with Section 26 05 29.
   E. Install enclosed switches plumb.
   F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
   G. Provide grounding and bonding in accordance with Section 26 05 26.
   H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
E. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING
A. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.

3.05 CLEANING
A. Clean dirt and debris from switch enclosures and components according to manufacturer’s instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 28 13 - Fuses: Fuses for fusible switches.

1.03 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
F. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
H. NFPA 70 - National Electrical Code.
I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
K. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
   3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   6. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor
      controllers, enclosures, overcurrent protective devices, and other installed components and
      accessories.
         1. Include characteristic trip curves for each type and rating of overcurrent protective device
            upon request.
   C. 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.
   D. Project Record Documents: Record actual installed locations of controllers and final equipment
      settings.
         1. Include nameplate data of actual installed motors and associated overload relay selections
            and settings.
   E. Maintenance Data: Include information on replacement parts and recommended maintenance
      procedures and intervals.
   F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or
      heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to
      internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
   A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
   D. Substitutions: See Section 01 60 00 - Product Requirements.
   E. Source Limitations: Furnish enclosed motor controllers and associated components produced
      by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED CONTROLLERS
   A. Provide enclosed controller assemblies consisting of all required components, control power
      transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete
      operating system.
   B. Provide products listed, classified, and labeled as suitable for the purpose intended.
   C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as
      complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated
      on the drawings.
D. Service Conditions:
   1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures:
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   3. Finish: Manufacturer's standard unless otherwise indicated.

H. Instrument Transformers:
   2. Select suitable ratio, burden, and accuracy as required for connected devices.

I. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Configuration: Full-voltage non-reversing unless otherwise indicated.
   3. Disconnects: Circuit breaker type.
      a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
      b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
      c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
   4. Overload Relays: Bimetallic thermal type unless otherwise indicated.

J. Manual Motor Starters:
   1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
   2. Configuration: Non-reversing unless otherwise indicated.
   3. Fractional-Horsepower Manual Motor Starters:
      a. Furnish with toggle operator.
      b. Overload Relays: Bimetallic or melting alloy thermal type.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.

2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.

3. Trip-free operation.

4. Visible trip indication.

5. Resettable.
   a. Employ manual reset unless otherwise indicated.
   b. Do not employ automatic reset with two-wire control.

6. Bimetallic Thermal Overload Relays:
   a. Interchangeable current elements/heaters.
   b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
   c. Trip test function.

7. Melting Alloy Thermal Overload Relays:
   a. Interchangeable current elements/heaters.

B. Circuit Breakers:
   1. Interrupting Capacity (not applicable to motor circuit protectors):
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

   2. Motor Circuit Protectors:
      a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
      b. Provide field-adjustable magnetic instantaneous trip setting.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 20 VA spare capacity.
   2. Include primary and secondary fuses.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install controllers in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required support and attachment components in accordance with Section 26 05 29.
E. Install enclosed controllers plumb and level.
F. Provide grounding and bonding in accordance with Section 26 05 26.
G. Install all field-installed devices, components, and accessories.
H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.

3.02 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
D. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.03 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.06 PROTECTION

A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION
SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Interior luminaires.
   B. Emergency lighting units.
   C. Exit signs.
   D. Ballasts and drivers.
   E. Lamps.
   F. Luminaire accessories.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 33.16 - Boxes for Electrical Systems.
   B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   C. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS
   C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   D. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems.
   F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
   G. NFPA 70 - National Electrical Code.
   I. UL 924 - Emergency Lighting and Power Equipment.
   J. UL 1598 - Luminaires.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
      2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
      3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
      4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
   2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.

E. 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.

F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide 10 year manufacturer warranty for all LED luminaires, including drivers.
PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

B. Substitutions: See Section 01 60 00 - Product Requirements, except where individual luminaire types are designated with substitutions not permitted.

2.02 LUMINAIRES

A. Manufacturers:
   1. Lithonia Lighting
   2. Lightolier
   5. Sylvania lighting
   6. Topaz
   7. Fine Lite
   8. Substitutions: See Section 01 60 00 - Product Requirements.

B. Provide products that comply with requirements of NFPA 70.

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. Recessed Luminaires:
   2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
   3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.Driver : 120-277 volt, 0-10 v dimming electronic type
   2. Tunable white LED driver : To be used only with permission from Owner.
   3. Use 3500 K LED fixtures with minimum CRI o f80 for interior fixtures.
   4. Use 4000 K LED fixtures with minimum CRO of 90 for laboratories and hallways/ corridors.
   5. Tested in accordance with IES LM-79 and IES LM-80.
   6. LED Estimated Useful Life: Minimum of 200,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EMERGENCY LIGHTING UNITS

A. Manufacturers:
   1. Dual Lite EVE-LED series
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

D. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 EXIT SIGNS
A. Manufacturers - Powered and Self-Luminous Signs:
   1. Dual Lite EVE LED series
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single or double as indicated or as required for the installed location.
   2. Directional Arrows: As indicated or as required for the installed location.

C. Accessories:
   1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   2. Provide compatible accessory wire guards where indicated.

2.05 BALLASTS AND DRIVERS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

C. Dimmable LED Drivers:
   1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
   2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.06 LAMPS
A. Manufacturers:
   4. Cree
   5. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.

B. Lamps - General Requirements:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.

3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.

4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.07 ACCESSORIES

A. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

B. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
   3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   4. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

F. Recessed Luminaires:
   1. Install trims tight to mounting surface with no visible light leakage.
   2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

G. Suspended Luminaires:
   1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

I. Install accessories furnished with each luminaire.

J. Bond products and metal accessories to branch circuit equipment grounding conductor.

K. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
   2. Install lock-on device on branch circuit breaker serving units.

L. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
   2. Install lock-on device on branch circuit breaker serving units.

3.04 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each product for damage and defects.
C. Operate each luminaire after installation and connection to verify proper operation.
D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING
A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
C. Exit Signs with Field-Selective Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.06 CLEANING
A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer’s instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES
A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.08 PROTECTION
A. Protect installed luminaires from subsequent construction operations.

END OF SECTION
SECTION 27 05 28.33
CONDUITS AND BOXES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
   1. Materials required for installation of interior pathways.
   2. Minimum requirements for installation of interior communication pathways.
B. Minimum composition requirements and installation methods for following:
   1. Conduit and Sleeve.
   2. Communications Backbox.
   3. Masonry Box.
C. Related Requirements: Comply with following:
   1. Section 078400 - Firestopping
   2. Section 270500 - Common Work Results for Communications.
   3. Section 270526 - Grounding and Bonding for Communications.

1.02 REFERENCES
A. Reference Standards: See Section 014200 - References and Section 270500 - Common Work Results for Communications.

1.03 SUBMITTALS
A. General: Submit in accordance with Section 013300 - Submittal Procedures and Section 270500 - Common Work Results for Communications.
B. Product Data and Installation Instructions: Submit for products included within this specification section.
C. Product Samples: As required.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT
A. A complete information package of all materials and equipment shall be submitted to the Owner for review by the Information Technology department for approval four (4) weeks prior to installation.
B. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.

2.02 CONDUIT AND SLEEVE
A. Rigid Steel Conduit: ANSI C80.1.
B. EMT and Fittings: ANSI C80.3.
   1. Fittings: Set-screw or compression type.
C. Mechanical Sleeve:
   1. UL listed and approved.
D. SLEEVES - One-inch (1") for gypsum wallboard assemblies where telecommunications cables will be installed - STI Fire-Stop Corp. #FS-100 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WL-3275. The cable fill capacity for these sleeves shall not exceed 48%. The Telecommunications contractor shall use the supplied fire-stop putty to satisfy this System requirement.
E. **SLEEVES** - One-inch (1”) for concrete and block wall assemblies where telecommunications cables will be installed - STI Fire-Stop Corp. #FS-100 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WJ-3141. The cable fill capacity for these sleeves shall not exceed 48%. The Telecommunications contractor shall use the supplied fire-stop putty to satisfy this System requirement.

F. **Acceptable Manufacturers:**
   1. STI
   2. Standard EMC/IMC Rated Conduit
   3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

### 2.03 COMMUNICATIONS BACKBOX

#### A. For Double Gang locations - At indicated locations provide and install one (1) Steel City #82181T-1, 5-Square Telecommunications Outlet Box with two (2) 1” conduits (standard EMT with plastic bushings) stubbed off above the ceiling. Attach one (1) Steel City double-gang Plaster Ring #82C-2G-1/2 to the front of the box for proper installation of the double-gang faceplate. This ring provides a ½” raise from face of box for ½” drywall.

#### B. For Single Gang locations - At indicated locations provide and install one (1) Steel City #82C-1G-1/2 Single Gang Plaster Ring, ½” raise. This ring shall be installed on the above double-gang Outlet Box #82181T-1.

#### C. Acceptable Manufacturers:
   1. Thomas & Betts/Steel City
   2. Hoffman Corp.
   3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

### PART 3 - EXECUTION

#### 3.01 CONDUIT AND SLEEVE

#### A. The contractor shall at all time’s install the conduits and sleeves in complete accordance with the National Electrical Code and NFPA, and shall be installed true and plumb. Support hardware shall be installed at 4’ intervals.

#### B. For conduit installed to transport inside rated cables, the EMT rating shall be acceptable.

#### C. All conduits installed for Telecommunications Cable routing, including, convenience outlet locations, riser conduits, and horizontal conduits of all sizes shall have one (1) nylon Greenlee Poly-line #502-1481.0 installed upon completion of the conduit installation.

#### D. If there are areas where sleeves are required through walls or in concrete slabs, the contractor is responsible for providing those sleeves as required to accommodate his work. All holes must be core bored. After completion of the Communications Cabling System, the contractor shall fire seal all communications sleeves with a UL approved fire stop in accordance with the NFPA (National Fire Protection Agency).

#### E. Reamed and bushed prior to cable installation.'

#### F. Secured with clamps or channel stock to prevent movement at wall penetration points.

#### 3.02 GROUNDING AND BONDING

#### A. Bond to ground openings in accordance with Section 270526 - Grounding and Bonding for Communications and Section 270500 - Common Work Results for Communications.

#### 3.03 FIRESTOPPING

#### A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 - Firestopping and Section 270500 - Common Work Results for Communications.

END OF SECTION
SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Extension of existing fire alarm system in accordance with UD Fire Alarm Design Standard. Applicable requirements included herein.
B. The fire alarm system shall be complete in all respects for operation and interface with building equipment related to or desired to be controlled by the fire alarm system. All work shall be coordinated with the Owner and their stakeholders. The fire alarm contractor/designer shall include in his/her design all work necessary to interface Heating, Ventilation and Air Conditioning shut-down, sprinkler monitoring and control, building systems monitoring, smoke management and other code specified supervisory functions. Any equipment, wiring, installation or other work necessary to finish all interface and output wiring or equipment shall be included in the design and subsequent bid packages.
C. Upon selection of Electrical Contractor, a kick-off meeting to include all stakeholders as identified by the Owner.

1.02 DEFINITIONS
A. ASME: American Society of Mechanical Engineers
   1. FACP: Fire alarm control panel.
   2. FM: FM Global (Factory Mutual)
   5. UL: Underwriters Laboratories

1.03 REFERENCES/REQUIRED CODE COMPLIANCE - (MOST CURRENT EDITIONS)
D. International Fire Code, Current Edition Adopted by the Authority Having Jurisdiction.
E. Underwriters’ Laboratories fire alarm and fire alarm equipment listings, approvals and standards.
F. Factory Mutual fire alarm approvals and standards.
G. NFPA 70 - National Electric Code, , Currently Adopted Edition by the Authority Having Jurisdiction.
   1. Americans with Disabilities Act, (except as modified per these specifications).
H. NFPA 90A - Installation of Air Condition and Ventilating Systems, , Currently Adopted Edition by the Authority Having Jurisdiction.

1.04 REQUIREMENTS OF REGULATORY AGENCIES
A. All equipment, components, wiring, design and the installation of all items as described or implied in this document shall meet all of the appropriate requirements in the codes, standards and guidelines as listed.
B. All equipment, components, wiring, design and installation of all items as described or implied in this document shall be UL listed and approved for the use intended.
1. All equipment, components, wiring, design and installation of all items as described or implied in this document shall be reviewed and approved by listed code authorities. The Contractor shall be responsible to submit all design documents and obtain all approvals from each listed code authority only after the submissions have been reviewed and approved by the Owner. No submission will be made to a code official until the Owner has approved the shop drawings.

a. Code Authority review required for this project is as follows:
   1) Appropriate AHJ;
   2) Factory Mutual Global Company
   3) University Liaison Representative

C. The Contractor shall be responsible for all submission costs and the Contractor shall be responsible for obtaining all required approvals, permits, and acceptance inspections/approvals from all legal and/or required agencies, inspection organizations and insurance groups as listed in these specifications.

1.05 COORDINATION

A. The Contractor shall fully coordinate the design, equipment, devices, installation, wiring and connection of all fire alarm systems with the Owner and/or their authorized representative and all other related contractors throughout each developmental stage of the project.

B. Fully coordinate the installation of all systems with other contractors and other work in progress or proposed progress at the time of Contractors design and installation. It shall be the Contractor's responsibility to communicate with the Owner's on-site representatives and identify all other work or trades which will require coordination with the fire alarm system design and installation.

C. The Contractor shall include in his schedule key times to notify the University Liaison Representative for periodic inspection of the system installation. The University requires an inspection of the installation at the following points of:
   1. Shop drawing development
   2. 25% of rough in wiring installation
   3. Device and panel installation
   4. Pre-acceptance inspection by Department of Environmental Health and Safety (Fire Protection), Department of Operations and Maintenance Electronics Manager, and other representatives as necessary
   5. Final acceptance testing

1.06 SUBMITTALS

A. Submittals at Time of Shop Drawings and Shop Drawing Format

B. All shop drawings shall be approved by University Fire Marshal and when applicable Owner Representative prior to installation. Submit two copies of all shop drawings prior to equipment delivery and installation of wiring. Each shop drawing must be approved by the University Fire Marshal and when applicable, the Owner Representative prior to equipment delivery and installation.
   1. The bid drawings as provided are supplied in scale. The contractor shall be responsible to submit all approval drawings, shop drawings, and as-built drawings in a scale no smaller than 1/8 inch scale.

C. All shop drawings shall show proposed wiring diagrams point-to-point with labeled terminal and splice points, data sheets, equipment ratings, layout, dimensions, conduit, wire mold, material type and finishes.

D. Submit material list indicating proposed manufacturer’s name and design/installation data for all systems and materials listed, specified or intended for use by the Contractor.
   1. The Contractor shall be required to submit the following series of drawings:
a. Shop drawings
b. Panel drawings
c. Schematics of all auxiliary devices and auxiliary system connections such as HVAC, etc.
d. Contractor shall be responsible to provide all shop, panel, schematic and as-built drawings in a CAD format. Drawings shall be multiple-colored ink on high quality, white bond plotting paper of a standard size sheet as agreed upon with the Owner and shall include the following parameters:
   1) CAD (Computer aided drafting) form using an acceptable CAD system capable of producing the electronic media in an AutoCAD 2010 or greater version format.

2. The Owner shall own all electronic media and original drawings addressed under this specification. The Owner shall have the right to modify, reproduce, distribute and use the electronic media and original drawings in any fashion or for any use that the Owner may desire.

E. The Contractor and manufacturer shall retain a copy of all as-built drawings and documentation as discussed in these specifications. The Contractor and manufacturer shall not have the right to use any digital media, drawings, documentation or other material describing or relating to the fire alarm system without the express written permission of the Owner.

F. All drawings shall show building background features in “green” ink with single narrow pen width. Panel drawings shall show panel box and chassis in green.

G. All drawings shall show fire alarm and detection features in “black” ink with varying pen widths. Separate pen widths shall demarcate devices, point-to-point wiring, device labels, and notes.
   1. K. All drawings shall show underfloor fire alarm and detection features in “red” ink with varying pen widths. Separate pen widths shall demarcate devices, point-to-point wiring, devices labels, and notes.

H. All drawings shall show labels, wire sizes and other similar information in “blue” ink.

I. Contractor shall show exposed conduit or surface mounted devices or surface mounted Wiremold in “orange” with a heavy pen width. Contractor may use other colors to demarcate other features of information on the drawings, but such colors shall be consistent from drawing to drawing and legible.

J. Match wiring details, including number of wires per initiating and signal circuit, and location and type of end-of-line device to type of supervision specified.

K. Show locations of fire alarm control panels, NAC panels, surge suppression enclosures and documentation cabinets on drawings to ensure adequate space is available.

L. Ensure drawings and specifications agree with respect to type of cable specified and that cable specified is suitable for the environment of the specific project.

M. Contractor shall produce and provide electrical schematic diagrams of any electrical connections between the fire alarm system and building equipment. These drawings shall be submitted at the time of shop drawings and as-built drawing submission.
   1. As part of this project and included within the base bid cost, the Contractor shall provide the Owner with “as-built” drawings for the entire fire alarm system showing all features as described in these specifications in their entirety, in an “as-built” status. All changes and/or corrections to the approved shop drawings made during installation and testing shall be documented and shown on the final as-built documents.

N. Along with the as-built drawing submission, the Contractor shall supply three complete sets of AutoCAD files of all drawings including the panel drawings.
   1. The Contractor shall provide one complete set of documentation for onsite use. The Owner will return one of the three sets of documentation that are required back to the Contractor for installation into the documentation cabinet.
a. Note: It is the intent of this section to ensure that a complete and adequate set of documentation exists on-site and is available to service technicians, inspectors, and fire department. No documents or other items will be permitted to be stored inside of any fire alarm control equipment or other enclosure.

O. All shop drawing submissions shall include the following:
   1. A narrative description of the fire alarm system. The narrative description shall include an exact English description of all signaling arrangements, detection arrangements, output and supervisory functions.
      a. All panel drawings shall show power and battery calculations for the system. Panel drawings shall show all wiring, ribbon and other cable point connections. Show any field or manufacturer modifications to include dip switch set-up positions, jumpers and snipped components including wire color coding and labeling.
         1) The system drawings shall have a plan view of each floor and a detailed riser diagram.

P. Actual wire, wire mold and conduit runs with anticipated methods of matching backgrounds or concealment of wire and conduit. Conduit and wire mold placement must be approved by the Owner.

Q. System annunciation descriptors for each alarm, trouble and supervisory output signal. Such descriptors shall be in “plain English” for each alarm, trouble and supervisory output signal. The English annunciation descriptors shall use actual terminology used at the project building to include floor names and point of compass designations un-coded. Contractor shall confirm descriptors with the Owner’s on-site representative prior to shop drawing submission.
   1. Note: Code numbers, zone numbers or abbreviated text will not be approved without exception.
      a. Submission of coded, zoned or abbreviated text will be rejected at the time of shop drawing submission without cause or comment! If bidder does not understand this requirement, seek clarification from the Owner prior to bid submission. Only complete and understandable English descriptors for fire alarm point and trouble annunciation will be approved.
         1) Contractor shall show all exposed conduit (if any) at the time of shop drawings and received approval of the Owner. All exposed conduit must be clearly annunciated on shop drawings by use of heavy weight pen markings and color.

R. Submit one (1) actual sample of each type of device intended for installation. If devices differ from area to area, then two (2) actual samples of each type of device labeled for the specific area must be submitted. These items include but are not limited to the following:
   1. Manual Pull Stations
   2. Audio Devices
   3. Visual Devices
   4. Smoke Detectors
   5. Heat Detectors
   6. Duct Detectors and remote test switch
   7. Conduit and Pipe
   8. Wiring
   9. Junction and Back Boxes
   10. Din Rail Compression Terminal Blocks
   11. Weather Proof Enclosures
   12. Water Tight Junction Boxes
   13. Mounting Plates
   14. Addressable Modules (if not in Monitor control panel).
   15. Detail drawing and sample of each wiring connection to all devices and any proposed splice connections.
16. Wire mold and back box (if applicable).

S. Shop drawings shall include original design notes for basis of design.

1. Submittals at the Time of Acceptance Testing
2. Prior to acceptance test submit manufacturer’s descriptive literature of actual equipment installed and the following:
   b. Equipment and device operating instructions manual.
   c. Equipment maintenance and programming manuals.
   d. Equipment/system service and repair data manual.
   e. Parts lists.
   f. Spare equipment and parts equipment and inventory list.
   g. Testing and maintenance schedule as per requirements of these specifications.

T. For testing and documentation submittal requirements, see Testing and Documentation in these specifications.

1.07 WARRANTY

A. The successful Bidder shall be responsible for all warranty and guarantee issues regardless of subcontractors, vendors or others operating as subcontractors under the successful Bidders contract. Bid submission documents shall include a document executed by the successful Bidder’s senior corporate or company officer indicating that the successful Bidder understands that he/she is solely responsible legally and financially to the Owner for compliance to warranty and guarantee issues as follows:

1. All system equipment shall be guaranteed for a period of one year from date of final acceptance of each system in accordance with Part 5 of these specifications.
2. All raceways and wiring are guaranteed to be free from inherent mechanical or electrical defects for one year from the date of final acceptance of the systems in accordance with these specifications.
3. Regardless of typical manufacturer or Contractor canned warranties and guarantees, the base bid price shall include all fees for warranty or guarantee cost to include parts, labor, shipping, stocking, overhead, markup or other costs associated with performing work under the warranty or guarantee agreement. It is the intent of this section that the entire system will be warranted and guaranteed from any fault (other than an act of God or acts by other than the alarm system Contractor). If anything goes wrong with the system, the Contractor shall repair/correct at no cost to the Owner with components, parts and workmanship that are NEW, not rebuilt or reconditioned parts or equipment. If this intent is not clear or understood by the Bidder, the Bidder shall seek clarification from Owner prior to bid submission.

B. As part of the successful bidder’s warranty package, the successful bidder shall submit at the time of system acceptance under Part 5 of the specifications, a schedule of maintenance, testing, and service as prescribed by these specifications and referenced standards, for the first year warranty period, (see NFPA 72 for additional requirements). The cost for the first year maintenance and testing shall be included in the base bid price.

C. All warranty service that impairs the function of the fire alarm system shall be provided within four hours of notification to the Contractor. Cost for this service shall be included within the base bid price.

D. All warranty service that does not impair the function of the fire alarm system but is obligated under the warranty shall be performed within 24 hours of notification to the Contractor unless otherwise approved by the Owner.

E. Warranty starting period shall be based upon the determination of substantial completion as defined by the American Institute of Architects General and Federal Supplementary Conditions of The Contract for Construction, AIA Document A201-1976 and A201/SC-1977. For purposes
of this work, Owner shall be known as the “architect” regarding implementation of substantial completion.

1.08 QUALIFICATIONS

A. Contractor shall be licensed with the State and Locality of the project. Contractor shall (or contractually be supported by a company) specialize in fire alarm systems and have a minimum of five years of documented experience with the design and installation of the actual system and devices being installed.

B. Contractor shall have (or contractually be supported by a company) on staff and assigned to the project a NICET Level IV certified person for fire alarm systems. Such person shall have a minimum of ten years of documented experience in the design and installation of NFPA compliant local fire alarm systems.

C. The Contractor shall assign the NICET Level IV certified person to supervise the preparation of all technical documentation, drawings, installation, testing and acceptance testing as required by these specifications. The NICET Level IV certified person shall be present at shop drawing review meetings, design issue meetings and all acceptance testing.

D. Equipment manufacturer shall be a company specializing in NFPA 72 fire alarm and detection systems with a minimum of ten years of documented experience. All qualification documentation shall be submitted at the time of bidding and verified at bid acceptance.

E. Contractor shall assign to the project a project manager who is experienced in the installation of fire alarm systems. The Project Manager shall be assigned to the project as his primary responsibility. He shall be dedicated to the design, installation and successful completion of a complete and working system. The Project Manager shall demonstrate qualification through experience and/or education to the satisfaction of the Owner. The Project Manager shall supervise the preparation of all technical documentation, drawings, installation, testing and acceptance testing as required by these specifications. The Project Manager shall have a position within his/her company that allows him/her to make decisions and commit his/her company legally and financially so as to minimize corporate bureaucracy during the resolution of issues and problems.

F. All qualification documentation shall be submitted at the time of bidding and verified at bid acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The existing fire alarm system is a Siemens FireFinder. The fire alarm vendor shall be Siemens without substitution.

B. Substitute equipment proposed as "equal to" equipment as specified shall meet or exceed the requirements of the specifications

C. The submitter of substitute equipment shall provide proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment. This proof shall be provided by an analysis of the substitute equipment against each system and component specified. The analysis shall use a copy of each listed manufacturers (Simplex, Siemens, Notifier) equipment and specification manuals. The analysis shall compare the substitute equipment with the specified manufactures equipment by marking each paragraph as compliant or noncompliant as compared to the requested substitute equipment.

D. Along with the analysis, the submitter shall provide a letter from the substitute manufacture that certifies the information presented as either compliant or non-compliant, including a detailed explanation of each paragraph identified as non-compliant. The letter shall be signed and sealed by the substitute manufactures registered electrical engineer, substitute manufactures
registered fire protection engineer or substitute manufactures NICET IV certified technician (in
fire alarm).

E. In order to ensure that the Owner is provided with a system that incorporates required
survivability features, this letter shall also specifically certify that the system is capable of
complying with the test requirements of this specification and quality testing as specified by the
three listed products in section

2.02 INITIATING DEVICES - GENERAL REQUIREMENTS

A. Manual Pull Station: Double action, addressable. Flush and/or surface mounted as indicated by
the specific building construction or drawings and as identified in Part 4 of these specifications.
All manual pull stations must be keyed alike to the fire alarm control panel. Allen wrench
opening devices not permitted.

B. Heat Detector in conditioned spaces: Shall be addressable combination rate-of-rise and fixed
temperature, rated 135 degrees F for conditioned spaces. Contractor shall survey areas where
heat detector is to be installed for possible need of higher fixed temperature rating.

C. Heat Detector in unconditioned spaces: Shall be Thermotech model 302ET or EPM anticipation
type self- restoring rated at 194 degrees F or match existing. All heat detectors in unconditioned
spaces shall be individually addressable through monitor zone actuated modules. Contractor
shall survey areas where heat detector is to be installed for possible need of higher fixed
temperature rating.

D. Smoke Detectors: Style and design shall be photo electronic with base having visual indication
of detector actuation, bug screen and suitable for mounting on 4 inch outlet box and/or low
profile wire mold back box. Detector and/or fire alarm panel shall have environmental
compensation and provide automatic signal for dirty detector in advance of and prior to reaching
alarm threshold. Smoke detection locations to include all Storage rooms, IT/NSS Server
Rooms, Electrical Rooms, Common Corridors and Tops of Stairwells, unless otherwise
specified by UD Fire Marshal.

E. Signaling Devices

1. Strobe Lights - where noted on drawings: Owner’s choice based upon contractor submittal
approvals. Style and type shall be visible notification appliances with 1Hz strobes.
Contractor shall provide both wall mount and ceiling mounted visible appliance assembly
with white housing and clear lens in accordance with NFPA 72, meeting the requirements
of ADA. Where strobe lights are shown on the drawing to be mounted on walls, the strobe
light shall be mounted at a minimum of 80” and a maximum of 90” above the finished floor.

F. Horn: Owner’s choice based upon contractor recommendations and submittals. Device must be
approved by the Owner. Color shall be white. Contractor must provide both ceiling and wall
mounted versions.

G. Combination Horn & ADA Strobe: Owner’s choice based upon contractors recommendations
and submittals. Device must be approved by the Owner. Color shall be white. Contractor must
provide both ceiling and wall mounted versions.

1. Transmission of Signals: All fire alarm control panels shall be equipped with RS 232 Cards
and Ports to accommodate and be fully compatible with Keltron LS 922 IP Transceiver for
transmissions to UD PD remote station alarm receiving center (Keltron LS-7000), unless
otherwise approved by UD Fire Marshal.

2. Upon consultation with the Department of Environmental Health and Safety, Facilities
Electronics Manager and the University Liaison Representative and the design team, the
fire alarm system shall also include an exterior alarm light and horn. The alarm light shall
be a 360º revolving red light, weather tight seal and approved for use in exterior locations.
Each exterior light shall be combined with an exterior audio horn in a weather tight
enclosure approved for exterior use. The alarm light can be powered by ordinary building
AC power and need not be provided with a secondary power supply. Location of the
exterior light and horn shall be as shown on the drawings and shall be coordinated with the Owner for elevation and placement.

2.03 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Shall be wired in accordance with NFPA 72 Local Fire Alarm Regulations and NFPA 70, Section 760. Each power source shall be obtained from an emergency power circuit and the breaker shall be marked “FIRE ALARM POWER SOURCE” and be provided with a “red” locking device so as to prevent accidental power loss. Contractor shall be responsible to run all power from the closest emergency circuit panel to the fire alarm system.

B. Initiating, Signal and Communication Buss Circuits: Shall be Aerospace Wire & Cable Inc., Aerospace
   1. #7140 18/2 TW/SH 200 deg.C. FPLP (New York City Certified)
   2. #7130 16/2 TW/SH 200 deg.C. FPLP (New York City Certified)
   3. #7120 14/2 TW/SH 200 deg.C. FPLP (New York City Certified)
   4. #7110 12/2 TW/SH 200 deg.C. FPLP (New York City Certified)
      a. Any and all fire alarm cable used in this system shall be "solid copper" conductors. No exceptions.
      1) Important Note: 12 inch wire samples for 18 T/S, 16 T/S, 14 T/S and 12 T/S shall be submitted at the time of shop drawing submittals and prior to material purchase and installation. Wire samples shall be approved by Owner prior to purchase.
         (a) “Or equal” for wiring: NONE
         (b) Recommendation: contractor to purchase and use Cyclops Data Cable Stripper Ideal #45-514 Wire Stripper to strip the Aerospace wire to make project easier and minimize wire damage.

C. Use 14 AWG (minimum size) twisted/shielded solid conductors for fire alarm indicating circuit conductors. All communication bus cable shall be 18 AWG twisted/shielded solid copper wiring using fire alarm listed plenum cable in all exposed areas. Any area subject to moisture or the effects of weather shall use water resistant conduit, enclosures, fittings, adapters, and like equipment. This includes all exterior mounted devices. Weather tight and water resistant installation shall extend for 12 inches within building envelope.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install system in accordance with Manufacturer’s instructions, code requirements and these specifications.

B. All devices, boxes and conduit shall be installed plumb and level.

C. Install manual pull stations with operating handle at 48 inches above finished floor. Install audible and visual devices as noted on drawings. All wall mounted visual devices shall be mounted no less than 80 inches above finished floors.

D. All devices shall be securely mounted with approved back box. All back boxes shall be recessed in walls or of an approved surface mount, wire mold type. Standard back boxes and extension rings with knockouts are not permitted when location requires surface mounted box. Contractor must use a finished back box suitable for painting. Only approved and appropriate type of conduit connectors shall be used for connection to back boxes.

E. Note: It is the intent of this section to only allow recessed fire and device installations in wall and ceilings of finished spaces. Wire mold and surface mounted conduit will only be permitted by the Owner on a case-by-case basis at the time of shop drawings. Contractor shall bid the project to exclude surface mounted wiring and devices and approach surface mounting on an individual
basis only. All surface mounted devices, conduit or wire mold shall be clearly shown on the drawing in a color specified by submittals details previously listed in this specification.

F. All wiring for initiating, signaling and auxiliary devices shall be installed in "red" Allied Tube Fire Alarm EMT or equal conduit, or wire molding except those areas where the wire can be fished in walls or hung above suspended ceilings. When wire is installed above ceilings and not in conduit, it must be run above the bottom of any red steel (or other type of super structure) and supported every 4-1/2 feet by a J strap or other approved support device. Wiring shall not be laid directly on a ceiling or supported by pipes, duct work or other building equipment. All wiring shall be secured within 12 inches of all junction boxes, back boxes, other devices or splice connections. All conduits shall be secured to building structure every 4 feet. When construction is of a wood frame, wire staples shall not be used to secure wire in place of J strap.

G. All fire alarm cabling and/or devices which are installed within 10 feet of water or sprinkler equipment shall be installed in Sealtight conduit with liquid tight connections and liquid tight (waterproof) boxes. When there are three or more monitoring/alarms points within the same area, monitor relays shall be mounted with a NEMA 4 Hoffman.

H. Mount end-of-line (EOL) devices in a back box. All end-of-line resistors shall be landed on terminal strips mounted into device back boxes or appropriate electrical enclosures or in a separate junction box adjacent to the last device in circuit. Each EOL device back box shall be labeled “EOL” and be visible from front of device. If “EOL” is mounted in separate junction box, the face of the box shall be labeled. All end-of-line device leads shall be insulated from short conditions by use of approved heat shrink wire insulation.

I. All wiring connections to sprinkler system water flow switches, sprinkler and/or fire pump system valve tamper switches, fire extinguishing systems, duct detectors and building interface equipment shall use conduit to within ten feet of device wherein the conduit shall terminate at a junction box. From the junction box to the device, the fire alarm wire shall be run in an approved Sealtight conduit and secured at each connection point to withstand a 50 pound pull force.

J. Automatic Detector Installation: Devices shall be installed as per the manufacturer requirements, NFPA 72 and these specifications. All detectors shall be securely mounted with approved back box. All back boxes shall be recessed. Only approved and appropriate type of conduit connectors or strain relief connectors shall be used for connection to back box.

K. Any wire entry or exit from a device, conduit or Sealtight shall be through an appropriate and approved box which is designed and installed to prevent chafing, cutting or other damage to the cable. All connections to devices, boxes, back boxes and like devices including any wiring exiting properly terminated conduit or EMT shall be provided with strain relief sufficient to secure cable at the point of entry or exit. Strain relief from back boxes, devices junction and panel boxes for wire cable shall consist of Arlington Ind., Inc LPCG50 connectors for single cable entry and Arlington NM 840 series for multiple cable entry.

L. Any conduit that is installed within areas subject to moisture, rain or water drainage shall be installed using approved water resistant and watertight conduit, enclosures and like equipment.

M. All system devices, panels and junction boxes shall have a unique identifier number which shall be:
   1. Labeled on each device, panel and junction box with a durable label capable of surviving environmental conditions.
   2. Labeled on all drawings.
   3. Labeled on all parts lists and required testing documentation.
   4. The unique identifier numbering system shall be approved by the Owner at the time of shop drawing submittals.
      a. Label for smoke detectors shall be installed on the base and readable from the floor at a distance of 10 feet.
1) Note: The intent of this requirement is to have each and every device and component (except panel components) installed with a logical and unique number whereby all inventory, documentation and life effort can be tracked by the unique number. Device labels shall be designed and installed to have a survival life of 10 years.

M. Each conductor (individual wire) shall receive a unique and durable wire number at each terminal block, slice connection, device terminal and any other location where a conductor is landed. Only “Brady Permasleeve” heat shrink wire markers will be permitted. No other label/marker systems shall be approved. In areas where the atmosphere is unconditioned, the wire number shall be protected with a clear heat shrink protector sleeve.

1. System devices that are located above a suspended lay-in ceiling shall have the heat shrink wire markers installed on each cable 12 inches before entering the back box and 12 inches after exiting the back box.

2. Cable labeling in junction panels, control panels and other covered boxes shall have the shrink wire marker installed at the end of the cable prior to the protective heat shrink stripping cap. See wiring detail on bid drawings.

3. Each wire number shall be shown on the final as-built drawings or on a separate approved document which shall be included in the final documentation and describes the wiring to each device as follows:
   a. Device    Circuit    In From/ Last/Next Wire
   b. Type Out to Termination No. Type   Color
   c.                                                                acionales y descripción de las conexiones de cada dispositivo.

N. The power supply surge suppression device(s) shall be installed in a separate NEMA 4 enclosure adjacent to each fire control panel and shall not be installed inside of the fire control panel. The surge suppression enclosure shall be labeled “Power Supply Surge Suppression” and marked with a unique identifier number. The surge suppression enclosure shall be of sufficient size to contain all components of the surge suppression system and including terminal strips. All wire connections between the surge suppression devices and the fire alarm control panel shall be in conduit. It is the intent of this specification to require additional and redundant surge suppression protection for all system components whenever they receive AC or DC power.

O. When installing wire numbers at back boxes, the wire numbers shall be installed on each cable inside of the back box when the back of the back box is not accessible (i.e. when the back box is installed on hard ceilings, on concrete or block surfaces or in gypsum walls). If the back of the back box is accessible, then the wire number shall be installed as listed in section M (1) above.

P. The labeling of system devices and other equipment may be accomplished by using a P-touch type labeling system. No handwritten labels or “Sharpie” markers will be permitted.

Q. Traditional wire ties are permitted for use in the system to secure wire bundles. The contractor shall provide written instruction to each employee on the correct use of wire ties so as to avoid compression of the cable jacket, shield or conductor insulation. Wire ties may not be used to secure cables to J strap, building structure, back boxes, panel enclosures, conduit or as wire restraint at device and other terminations.

R. All terminal blocks, cards, relays and other devices shall be rigidly mounted within a cabinet enclosure or back box using screws, bolt & nut or epoxy glue. Double back tape or similar mounting systems shall not be permitted.

1. Wire terminations, splice connections and all other connections shall be made by the use of UL listed compression terminal blocks as follows:

2. All panel and junction box connections:

3. “Square D” 9080 GM6 Terminal Blocks, 600V, 30A with Din Rail or equal.

4. All back box connections for shields and small connections:

5. “Ideal” #89-608 Barrier Strip, 600V, 20A or equal
6. No wire nuts or crimp connection devices will be approved. When terminal blocks are added to devices which incorporate a pig tail, the terminal block shall be securely mounted with mechanical fasteners (no double back tape) in the back box or on the back of the fire alarm device.

7. All Din Rail terminal blocks shall be provided with a number which shall be shown on all panel drawings and as-builts along with wire numbers.

S. All conduit, devices and other system components that are installed in areas subject to moisture, water, rain or water drainage shall be installed using approved water resistant and water tight conduit, NEMA 4 enclosures and like equipment.

T. Provide power supply wiring to fire alarm system components from building electrical panel. Circuit breaker shall be sized in accordance with fire alarm system demand and the NEC. Branch circuit breaker shall be clearly labeled for fire alarm service, contiguous to the circuit breaker toggle switch and the toggle switch shall be provided with a lock to prevent accidental movement.

U. Provide all low voltage signal wiring for systems specified herein in a workmanlike manner. Provide system raceways in accordance with manufacturer’s requirements for installation of system’s wiring. Provide and tag conductors at all junction and terminal points and identify by same number on all shop drawings. All conduit, cable, outlet and mounting boxes required as part of mounting arrangements shall be color-coded red if not in public area.

V. Protect exposed wiring installed above ceiling construction from physical damage where necessary by conduit, guard strips or other approved means. Install all drops to wall devices in wire mold unless fished in walls. Properly support all low voltage cables and conduit from the building structure by the use of J straps. At those points where the wire descends below the concrete/steel structure, the wire must be provided with adequate strain relief which is designed not to cut or ground the cable shields. The wire shall descend plumb to the device or transition. Secure cable in place at intervals not exceeding 4-1/2 feet and within 12 inches from every cabinet, box or device. Cable stress relief shall be required for all connections to devices and boxes.

1. In running plenum cable not in conduit, all J straps running parallel with red steel (and/or wood framing) shall be turned up on the bottom flange of red steel (and/or wood framing) so as the wire run is on top of the bottom flange and cradled by the bottom flange. Where intersecting beams must be crossed, the wire run shall be routed as follows:
   a. When a corrugated steel flute is available above the red steel, the wire shall be routed through the flute and over top of the steel beam.
   b. When a corrugated steel flute is not available, the wire run shall be taken under the intersecting beam and held off the beam by J strap on each side.
   c. When running wire through wood flooring and truss members, the wire shall be secured so as not to be exposed to metal gusset edges or other metal objects that could cause damage to the cable from weight, strain or vibration over time.

W. When any wire run transitions from above a suspended or hard ceiling into a room or area which has no ceiling and is below an elevation of 7 feet above the floor, the entire wire run shall be run in red EMT through the entire room or until the red EMT terminates within a junction or back box. The intent of this requirement is to not permit any exposed plenum wire in areas without ceilings.

X. Install all fire alarm wiring in separate raceways. Do not mix 120 volt AC power with fire alarm initiating, signaling or communications cable in the same raceway. All 120 volt AC power wiring shall be separated from initiating, signaling or communications cable inside of FACP, NAC or junction boxes with a paper or fiber board separation.

Y. Be responsible for assuring that conduit sizes and the wire quantity, size and type are suitable for the equipment and conditions as they exist. Review the proper installation of each type of
device with the equipment supplier. Make final connections between the wiring and equipment under the supervision of equipment manufacturer’s certified technician and NICET person in charge.

Z. Be responsible to seal all floor, ceiling and wall penetrations with approved materials which will provide the equivalent fire resistive rating as that of the wall, floor or ceiling that was penetrated. Contractor shall also be responsible to re-seal or repair any access ways or penetrations made through draft stops or fire stops with materials and workmanship which equals the original intended fire rating of the draft stop. All fire penetrations shall be sealed the same day of penetration.

AA. All fire alarm wiring which is not concealed above ceilings, fished in walls, or run in Sealtight, shall be installed in conduit and/or wire mold unless specified otherwise on drawings.

AB. Elevators: Smoke detectors shall be located outside each elevator landing in accordance with NFPA 72 and programmed to recall the protected elevator. Heat detectors shall be located within two feet of each sprinkler head that is located within the elevator machine room. The FACP shall be programmed to shunt trip the elevator upon activation of the machine room heat detector.

AC. Where required, all smoke detectors and alarm monitor or control devices which are to be installed under a raised floor shall be provided with an approved drip shield to protect the device from water that could drip from above or on top of the raised floor surface. Each device shall also be provided with LED annunciation at an approved location. The design and installation method shall be proposed by the contractor and shall be subject to the approval of the Department of Environmental Health and Safety at the time of shop drawings.

AD. All junction and termination boxes using Din rail shall have a hinged cover with a latch, or keyed locked keyed alike to the primary FACP. Box covers with screws or other fasteners will not be accepted. This includes surge suppression and similar enclosures.

1. Wire Jacket Ends and Shield Drains
2. All signal, communications and power wire (low voltage) shall be twisted/shielded. There shall be no use of unshielded cable on the project with the exception of 120 VAC power to surge suppressors and system power supplies. All cable and shields shall be installed as follows:
   a. Initiating circuits: all shields shall be carried through each device back box through the use of a compression terminal block as specified in these specifications. Each shield drain wire shall be insulated with “clear” heat shrink wire insulation installed from the cable end heat shrink strip to the terminal block. The shield shall be landed at the “panel end” as per manufactures recommendations. The “field end” of the shield shall be terminated in the last device back box at the compression terminal strip.
   b. Indicating horn, speaker (where applicable) and strobe circuits: all shields shall be carried through each device back box through the use of a compression terminal block as specified in these specifications. Each shield drain wire shall be insulated with “clear” heat shrink wire insulation from the cable end heat shrink strip to the terminal block. Shield landing shall be as follows:
      1) In NAC panels, the shield shall be landed on an acceptable ground at the junction panel located adjacent to the NAC panel. The field end of the shield shall be terminated in the last device back box, in the compression terminal strip.
      2) In FACP or transponder/data collection panels, the shield shall be landed as specified by the system manufacturer.
       (a) Communication, signal and data circuits shall be carried through each device junction box, back box, or other enclosure necessary through the use of a compression terminal block as specified in these specifications. Each shield drain wire shall be insulated with “clear” heat shrink wire insulation from the cable end heat shrink strip to the terminal strip.
shaded shall be landed at the panel as per manufactures recommendations. The field end of the shield shall be terminated in the last device back box, in the compression terminal block.

AE. Wire stripped ends shall be protected with “red” heat shrink insulation placed at the cable jacket end to insulate the transition from the cable to the stripped drain wire.

3.02 FIELD QUALITY CONTROL
A. All system testing shall be in accordance with NFPA 72 and these specifications.
B. Contractor shall be responsible to install all system components, wiring and conduit in a workmanship like manner and to the satisfaction of the Owner. The Owner shall determine the acceptable level of workmanship. Examples of existing installations or other contractor installations shall not be used for evaluation of acceptable workmanship under the fire alarm contract work. Only the highest quality workmanship will be accepted. There are no exceptions to this requirement.

1. Fire Alarm Wire and Cable Color Code

C. Provide fire alarm circuit conductors with color coded insulation, or use color tape at each conductor termination and in each junction box. Color code shall be specified by the Contractor at the time of shop drawings and shall be consistent throughout all fire alarm systems. Color code shall be listed on all shop and as-built documentation/drawings.

3.03 ELECTRICAL SERVICE FOR INSTALLATION OPERATIONS
A. Contractor may use any existing electrical service, outlet or system available where approved prior by the Owner. Contractor shall not assume that evidence of existing outlets implies energized circuits.

1. When electrical service is not available, the contractor shall provide his own electrical supplies from generators or other suitable service.

B. Contractor shall provide all necessary cords, leads, generators and other necessary equipment required to perform installation, testing and demolition work.

3.04 CEILING DEVICE INSTALLATIONS
A. All installations of ceiling devices including smoke detectors, horns and strobes and where installed in a suspended lay-in ceiling shall be provided with a ten foot coil of wire. The wire coil shall be secured at the floor/roof deck level just prior to the device drop using a “lose secured wire tie” so as not to crimp wire shields. In the case of minimal space above a suspended ceiling, the coil shall be secured to a J strap or other approved mounting point.

3.05 VISUAL STROBE SYNCHRONIZATION
A. All visual strobe devices that are within the same viewing area must be in synchronization. The contractor and equipment vendor shall provide a design and installation that meets the requirements of NFPA 72.

3.06 ALARM ACTIVATION SEQUENCE
A. Sequence of Operation. As a basic operation of the system the designer shall include at a minimum the following sequence of operations;

1. Upon any fire alarm:
   a. All audio and visual alarms to sound throughout the building or fire area as applicable and said fire area shall be identified and approved by the Department of Environmental Health and Safety.
   b. Annunciate specific device or zone in common plain English at the Fire Alarm Control Panel, printer and remote annunciators in plain English description. Annunciation descriptors shall be the standard terminology used by the University for the specific building and for each area within the building. Descriptors shall not be abbreviated. All
terminology and descriptors shall be approved by the University Liaison Representative at the time of shop drawings.
c. Cause transmission of an alarm signal to the University's remote station service.
d. Deactivate electro-magnetic door hold open devices.
e. Output fan shut-down if affected air handler is involved.
f. Activate other outputs as required by design.
g. Note: A general alarm device signal is any device signal that is not identified as a special or supervisory device signal.
h. Special systems may require a special operation sequence. Each special system shall be reviewed by the Department of Environmental Health and Safety and approved. Upon activation of any supervisory or trouble alarm shall cause the following:
i. Annunciate specific device or zone in common plain English at Fire Alarm Control Panel, printer and remote annunciators in plain English description. Annunciation descriptors shall be the standard terminology used by the University, for each area. Descriptors shall not be abbreviated. All terminology and descriptors shall be approved by the University Liaison Representative at the time of shop drawings.
j. Cause transmission of the supervisory or trouble alarm signal to the University of Delaware's Remote station service.

3.07 FIRE ALARM SYSTEM - ADDITIONAL REQUIREMENTS

A. Fire alarm system (including subpanels, transponders, DGP’s or NAC’s) power supplies shall be protected with separate surge protection in the power supply line feeding the fire alarm panel, releasing panel and NAC. Surge protection shall be redundant and independent of any surge protection provided in and listed for the fire alarm panel. The surge protection device shall be located within 5 feet of the fire alarm panel, sub panel, transponder or NAC, and be labeled “surge protection, fire alarm panel ##”. The surge protection shall be mounted in its own NEMA 4 electrical enclosure with label on exterior of enclosure.

B. Spare Parts. Contractor shall include in the base bid the cost to provide all manufacturer’s recommended spare parts and devices. At a minimum, the Contractor shall provide at the final acceptance test the following spare parts and devices:
   1. One smoke detector of each type used on the project.
   2. One heat detector of each type used on the project.
   3. One manual pull station of each type.
   4. Two of each type of fuse used in each fire alarm system.
   5. One audio device of each type used on the project.
   6. One visual device of each type used on the project.
   7. Included shall be any remaining devices

C. All spare parts shall be listed on all inventory lists and each spare part shall be labeled for the specific system or component it is intended.

D. All secondary power supplies (batteries) shall be calculated in accordance with NFPA 72 and manufacturer’s recommendations and shall include design spare capacity. Battery size shall be increased by 20% above minimum calculation.

3.08 SPECIAL CONDITIONS

A. Contractor shall conceal all conduit and wiring above ceilings where applicable. The decision to allow exposed conduit shall be made by the Owner at the time of shop drawings. Any exposed conduit or wiring shall be clearly annunciated by the Contractor through the use of color code or other annunciation method on the shop drawings so that it can be easily identified during shop drawing review.

B. Contractor shall connect and monitor all alarm, trouble, and supervisory points for each fire suppression, fire pump and fire extinguishing system to the fire alarm system. It shall be the
responsibility of the contractor to coordinate with the Owner’s on-site representative to identify any and all such systems prior to development of shop drawings.

C. All manual pull stations shall be recessed and flush mounted with conductors concealed within wall or structure. This includes existing masonry surfaces. If an existing condition exists that will not permit recess and flush mounting (filled masonry), than the contractor shall plan to saw cut/channel the masonry wall to install the raceway and pull station. In the rare event that the Owner approves an alternate of surface mounted wiremold, all wiremold shall be flush against the wall or mounting surface without any space or bends. All wire mold raceway shall enter an approved wire mold back box flush against the wall or mounting surface.

D. If wire mold is approved and installed for this project, it shall be metallic and fastened flush to the wall surface without spaces under the wire mold. Any spaces created by wall surface deviations such as mortar joints and like transitions shall be filled with an appropriate paintable caulk. All wire mold shall be uniquely marked on the shop drawings to show all locations proposed for use.

3.09 ACCEPTANCE, TESTING, AND DOCUMENTATION

A. General
   1. All fire alarm systems, component parts, and supervisory functions shall be subject to acceptance testing to be conducted by the Contractor. The system shall be completely operational, finished and ready for acceptance testing in accordance with the anticipated project schedule.
   2. The Owner shall be notified at least 15 working days prior to acceptance testing with the specific date, time and system being tested.
   3. All approvals (with the exception of the acceptance test approval) required by these specifications shall be completed and submitted with the notification of acceptance test date as required.
   4. All as-built completed drawings required by these specifications shall be completed and submitted with the notification of acceptance test date as required.
   5. All Contractor field testing and manufacturer testing documentation as required by these specifications shall be submitted with the notification of acceptance test date as required.
   6. Contractor shall provide the Owner with three complete manuals of “the specific” fire alarm system being tested. The manuals shall document all components of the system identified by unique number, consistent with the shop drawings and “as-built” drawings.
   7. Contractor shall provide all items in bounded and labeled three-ring binders with zippered ends. The binders shall be labeled on the cover as follows:
   8. Each section of the manuals shall be arranged with section tags and documentation as follows:
      a. Project Cover sheet listing project name, contractor, vendor, and consultant.
      c. Service Directory.

B. Fire Alarm Approvals. Include:
   1. Copy of Fire Marshal Application for fire protection plan review, completed and marked paid.
   2. Copy of Fire Marshal’s Office plan approval form.
   3. Copy of Fire Alarm Signaling Systems Company License.
   4. Copy of NICET Certification, certificate of technician.
   5. Original of NFPA 72 Fire Alarm System Certification and Description.
   6. Copy of Fire Marshal’s System Inspection and Final Approval Form.
      a. Narrative of system description and operation. Include original design notes for basis of design.
      b. System installation and service manual. (Note that these are two separate documents.)
c. Equipment inventory list, with unique identifier labels for each device. Include equipment data sheets.

d. Parts list of all components, modules, devices, wiring harness, and cross referenced with unique identifier number/label.
   1) Divider section labeled “Punch List Items”.

e. Manufacturer/vendor system testing. This section shall contain all installation, check-out and acceptance testing data as per these specifications.

f. First year warranty and test schedule.

g. Wire list.

h. Alarm and Supervisory Zone Descriptor. As worded using actual plain English descriptors.
   1) As-built drawings. To be installed in protective clear plastic sleeves. One drawing per sleeve.

i. CD or other acceptable media with an electronic copy of AutoCAD as-builts.

j. All documentation listed in this section shall include a digital copy on a “thumb-drive” device included with each binder. This includes all as-built drawings, PDF copies of manuals, approvals and items.

C. At the conclusion, the Contractor shall document each part or test result from the acceptance test in a form suitable for installation into the required three-ring zippered binder. It is recommended that the test data collected in the acceptance be performed and documented during Contractor’s system check-out and documented in binder prior to delivery to The Owner. If this recommendation is accepted, acceptance test will be performed much faster and any delays in release of final payment will be avoided.

D. The Owner acceptance of system shall not be completed until all faults, malfunctions and documentation as required by these specifications have been completed, delivered and verified by the Owner.

3.10 FIRE ALARM SYSTEM TESTING

A. The fire alarm system shall be tested in accordance with the guidelines set forth in these specifications and NFPA 72. All testing shall be documented in a report form to the Owner and in accordance with these specifications. A written copy of testing documentation shall be provided to the fire marshal at time of acceptance testing. Documentation and testing shall consist of each item noted in NFPA 72 and the following:

1. Manufacturer’s representative check. Prior to placing power to the system, a Manufacturer’s representative check-out shall be conducted and verified in writing to the Owner. The report shall contain the following, but shall not be limited to:

   2. A complete list of equipment installed and wired.

   3. Indicate that all equipment is properly installed and conforms to the manufacturers and these specifications.

   4. Test individual devices in accordance with NFPA 72 acceptance test criteria Chapter 2, 3, 4, 5, 6, and 7.

   5. Technician’s name, manufacturer certification, and date.

   6. Test of individual inputs and outputs for intended function and supervision.

   7. Test to verify the functional operation of the central monitoring point and remote annunciators individually and as a complete system under the following conditions:
      a. Normal operational condition
      b. Alarm condition
      c. Under primary power failure

   8. Test and demonstrate proper coordinated interfaces with HVAC, suppression and extinguishing systems and any other interfaced system or device, under the following conditions:
      a. Normal operational condition
b. Alarm condition  
c. Under primary power failure  
d. Output function features  

9. Measure, adjust, and record each smoke detector (including duct smoke detection and beam detection), to its medium sensitivity setting. This must be performed at the operational location of the unit and under normal environmental conditions. The sensitivities shall be recorded with serial number, location number and model number for each detector. 

10. Confirm that smoke detectors are within their UL listed sensitivity production window. All sensitivity testing shall be recorded in the documentation or as-builts as required under Section 5.1. All sensitivity recordation shall be in “percent per lineal foot light obscuration”, not voltage, using an approved smoke detector sensitivity testing apparatus as listed by the manufacturer. 

11. Confirm and document that all alarm point annunciation descriptors are correct, in compliance with shop drawings, presented in plain unabbreviated English, and are annunciated to all remote annunciators and printer as required by these specifications. 

B. Upon completion of fire alarm testing, the Contractor and respective Manufacturer’s authorized field engineer shall conduct functional and instructional tests for The Owner 

C. Acceptance testing shall be specified by the contractor. The Contractor shall develop an outline for approval by The Owner, but at a minimum, the testing shall be as follows: 

1. Confirm all documentation has been received: As-builts - check accuracy  
   a. plan views  
   b. riser diagram  
   c. panel drawings  
   d. battery calculations  
   e. Disk labeled  
   f. Thumb drive  
   g. Manual - check content  
   h. system descriptions  
   i. parts list  
   j. spare parts inventory  
   k. device cut sheets s installed  
   l. schedule for first year’s maintenance and testing  

3.11 TESTING DOCUMENTATION OF DEVICES AND SYSTEM 

A. Inspect panel for installation, power, etc. 

1. General walk-down of devices to identify any missing device or obvious problems. 
2. Test alarm and annunciation circuits for audio level with dB measurements. Test shall provide an audible alarm with each device on alarm during acceptance testing, hit alarm silence and go on. No walk test mode permitted for acceptance testing. 
   a. Test of battery backup.  
   b. full load test for five minutes  
   c. test and record voltage during full load test  
   d. test and record amps during full load test  
   e. test and record recharge amp rating  
   f. test and record battery draw during full load  
   g. normal standby mode in amps  
   h. test and record battery recharge voltage no load = vac  
   i. test and record battery recharge voltage with load = vac  

3. Test of primary power. 
   a. voltage= vac/vdc
b. circuit breaker tagged and locked open
   c. surge protection under full load after
   d. system has been operating on secondary power for 24 hours

   a. circuit #1 = amps
   b. circuit #2 = amps
   c. Inspect panel boards for faults.
   d. Check spare capacity of system.

5. Check supervision of all circuits, signal and detection.

6. A random sample test of detection, supervisory and pull station devices for function, supervision and proper installation.

7. Confirm English descriptors and labels for zones.
   a. A random inspection of junction boxes, terminal/splice point boxes, conduit, wiring and general installation features. Goal of inspection is review of installation for workmanship and specification issues.


9. Additional test as required by individual system design or arrangement.

B. The Contractor shall be responsible to conduct all acceptances testing with the Contractor’s calibrated equipment, in the presence of The Owner. The Contractor shall submit at the time of acceptance test notification and outline for approval by the Owner.

C. Audio Acceptance Testing and Adjustments. At the time of acceptance testing the contractor shall conduct the standard NFPA 72 audio level testing throughout the building. In addition, the contractor shall conduct specific audio measurements for the voice evac area. Based upon the readings, if audio levels are not adequate, the contractor shall adjust speaker wattages to bring the audio levels into compliance with minimum code levels.
   1. The contractor shall include in his base bid price sufficient labor to adjust 25% of all installed speaker locations from their original wattage tap to an appropriate up or down tap.
   2. Once wattage taps are adjusted, the contractor shall re-conduct the same audio readings and record the final audio levels on a set of as-built drawings for submission with final documentation as specified in these specifications.
   3. At the conclusion, the Contractor shall document each part or test result from the acceptance test in a form suitable for installation into the required three-ring zippered binder.

3.12 OWNER INSTRUCTION

A. Contractor or Manufacturer shall provide the Owner’s representatives with a minimum of two, two hour classes of formal instruction on the operation, maintenance, service and testing of the fire alarm system, devices and related building interfaces. The instruction shall be scheduled after acceptance testing but prior to final payment.

B. Contractor and/or Manufacturer shall provide to the Owner an instructional outline for each class with all visual aids. All classes shall be structured consistently with traditional educational standards with performance objectives and testing for all participants. Each student shall receive an instructional certificate indicating number of hours of instruction and satisfactory completion of the course. Owner may video tape class for future use.

C. Documentation
   1. Prior to acceptance testing the Contractor shall purchase and install a documentation cabinet adjacent to the primary fire alarm panel. This documentation cabinet shall be keyed alike with the fire alarm panel and shall be large enough to contain a complete set of documentation as described in these specifications. The cabinet shall be the same color and match the fire alarm panel.
3.13 DEVICES LABELING AND SOFTWARE

A. Device Demarcation
   1. Each and every alarm initiating device, supervisory device, monitoring device, control
      panel and junction box shall be provided with a unique number which shall be intended to
      specifically identify that item uniquely within its parent system. The unique number shall be
      clearly marked on the face of the device so as to be visible from 10 feet from a normal
      visual position. The type and style of unique label shall be approved by the Owner prior to
      installation. It shall be a type of label that will survive for a minimum of 10 years under
      installed conditions.
   2. The unique number shall be an identifier within a logical system and numbers shall be
      assigned in a logical and systematic order.
   3. The unique number shall be shown on all shop drawings and other documentation that
      annunciates, describes or documents said item. This would include inventory listing,
      materials lists and manuals submitted.

3.14 SOFTWARE AND PROGRAMMING

A. Copies and adequate explanatory documentation of all software and programming used in the
   fire alarm system shall be provided to the Owner within 30 days after acceptance testing
   approval.

B. The Owner shall own all software and programming that is part of the operational, updating,
   renovation and maintenance need of the system.
   1. If it is a condition of the Contractor or Manufacturer to require licensing of any software or
      programming, the Contractor and/or Manufacturer shall provide such licensing to the
      Owner as part of this project. Cost of such licensing shall be part of the base bid package.

C. The Owner shall have the right to modify, use or reproduce for his own use, any software or
   programming which is part of this project.

END OF SECTION