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Design Development

Project Manual

Van Buren Public Schools
Tyler Elementary School
Secured Entry Renovation
Belleville, Michigan

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DIVISION 02 – EXISTING CONDITIONS

Section 02 4119 – Selective Demolition

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

2. Perform sonar/ultrasound or other approved testing of entire floor slab prior to demolition to confirm all below slab structures, piping and conduit.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.

6. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

7. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

9. Remove demolished items and materials promptly and legally dispose of.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

2. Provide temporary weather and security protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage, unauthorized entry and damage to structure and interior areas.

3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

4. Cover and protect furniture, furnishings, and equipment that have not been removed.

DIVISION 03 - CONCRETE

Section 03 3000 - Cast-In-Place Concrete

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Concrete construction shall comply with the following ACI Publications:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5**.**
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
3. ACI 211, “Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.”
4. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
5. ACI 304R, "Guide for Measuring, Mixing, Transporting and Placing Concrete".
6. ACI 305R, Hot Weather Concreting".
7. ACI 306.1, "Standard Specification for Cold Weather Concreting".
8. ACI 308, "Standard Practice for Curing Concrete".
9. ACI 309R, "Guide for Consolidation of Concrete".
10. ACI 315, “Details and Detailing of Concrete Reinforcement.”
11. ACI 318, "Building Code Requirements for Reinforced Concrete."
12. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

C. Formwork shall conform to requirements of ACI 301 and ACI 347 "Recommended Practice for Concrete Work".

1. Formwork for unexposed concrete surfaces shall be APA Exterior Plyform BB or metal forms.
2. For exposed concrete surfaces, provide APA Exterior Plyform BB with MDO (medium density, smooth, hard, fused resin fiber overlay) or metal.

D. Reinforcing steel shall be placed in accordance with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" and shall conform to ASTM A615, Grade 60, deformed.

E. Welded wire fabric shall conform to ASTM A1064, furnished in sheets, not rolls.

F. Portland Cement: ASTM C 150, Type I, gray.

G. Fly Ash: ASTM C 618, Class C or F.

H. Normal-Weight Aggregates: ASTM C 33. Provide aggregates from a single source

1. Class: Severe weathering region, but not less than 3S for foundations and wall and 4S for flatwork.
2. Nominal Aggregate Size: In accordance with ACI 318.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

I. Lightweight Aggregate: ASTM C 330, 3/4-inch nominal maximum aggregate size.

J. Admixtures: Provide admixtures that contain not more than 0.05 percent chloride ions and that do not contain calcium chloride thyocyanates.

1. Air Entraining Admixture, for exposed concrete ASTM C260.

2. Water-Reducing Admixture, ASTM C494, Type A.

3. High Range Water-Reducing Admixture (Super Plasticizer), ASTM C494, Type F or G.

4. Water-Reducing, Non-Chloride Accelerator Admixture, ASTM C494, Type E.

5. Water-Reducing Retarding Admixture, ASTM C494, Type D.

6. Concrete Water Vapor Reducing Admixture (WVRA): A complex admixture for cementitious materials, free of volatile organic compounds (VOC), designed to naturally chemically react with pre-existing elements within the cementitious material to eliminate the route of moisture vapor emission by integrally and permanently closing the capillary system in the concrete and also makes the concrete impermeable to salt.:

a. Provide in all slab-on-grade, supported slabs, and exterior platforms, ramps and steps..

b. Products: Vapor Lock 20/20; Specialty Products Group (SPG); 877-957-4626.

K. Ready mix concrete shall comply with ASTM C94.

L. Concrete Mixtures

1. Class A: Normal-weight concrete used for footings and foundations.

a. Exposure Class: ACI 318 F2.

b. Minimum Compressive Strength: 4000 psi, at 28 days.

c. Maximum w/cm: 0.45.

d. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size.

2. Class B: Normal-weight concrete used for exterior slabs-on-grade and equipment pads.

a. Exposure Class: ACI 318 F3, C2.

b. Minimum Compressive Strength: 5000 psi at 28 days.

c. Maximum w/cm: 0.40.

d. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

e. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size.

3. Class C: Normal-weight concrete used for interior slabs-on-grade and equipment pads.

a. Exposure Class: ACI 318 F0.

b. Minimum Compressive Strength: 4000 psi at 28 days.

c. Maximum w/cm: 0.45.

d. Minimum Cementitious Materials Content: 520 lb/cu. yd.

e. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

f. Permeability-Reducing (Moisture Vapor Reduction) Admixture: Provide in slabs to receive adhesively applied flooring and moisture sensitive floor finishes.

4. Class D: Lightweight concrete used for interior suspended slabs and equipment pads.

a. Exposure Class: ACI 318 F0.

b. Minimum Compressive Strength: 5000 psi at 28 days.

c. Calculated Equilibrium Unit Weight: 120 lb/cu. ft., maximum, unless otherwise indicated on Drawings..

d. Minimum Cementitious Materials Content: 540 lb/cu. yd.

e. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

f. Permeability-Reducing (Moisture Vapor Reduction) Admixture: Provide in slabs to receive adhesively applied flooring and moisture sensitive floor finishes.

5. Class E: Normal-weight concrete used for interior metal pan stairs and landings:

a. Exposure Class: ACI 318 F0.

b. Minimum Compressive Strength: 4000 psi at 28 days.

c. Maximum w/cm: 0.45.

d. Maximum Size Aggregate: 1/2 inch.

e. Air Content: 0 percent, plus or minus 0.5 percent at point of delivery.

f. Permeability-Reducing (Moisture Vapor Reduction) Admixture: Provide at stairs to receive adhesively applied flooring and moisture sensitive floor finishes.

M. Concrete Finishing: Provide the following for conditions indicated:

1. Rough Form Finish: For formed concrete surfaces not exposed to view in finish work. Concrete surface having texture imparted by form material with tie holes and defective areas patched and fins exceeding 1/4” in height removed.

2. Troweled Finish: On interior slabs exposed in the finished work.

3. Broom Finish: On exterior platforms.

N. Concrete Hardener/Densifier (Sealer): Penetrating liquid floor treatment. Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dayton Superior; Densifier J13: www.daytonsuperior.com.

b. The Euclid Chemical Company; Euco Diamond Hard: www.euclidchemical.com.

c. Kaufman Products, Inc; SureHard: www.kaufmanproducts.net.

d. L&M Construction Chemicals, Inc, a subsidiary of Laticrete International, Inc; Seal Hard: www.lmcc.com.

e. PROSOCO, Inc; Consolideck LS: www.prosoco.com.

f. W.R. Meadows, Inc; Liqui-Hard: www.wrmeadows.com.

DIVISION 04 - MASONRY

Section 04 2000 - Unit Masonry

A. Furnishing and installation of unit masonry work including:

1. Brick.

2. Concrete masonry units.

B. Comply with requirements of ACI 530.1/ASCE 6 “Specifications for Masonry Structures.”

C. Brick:

1. Product: Subject to compliance with requirements, provide the following product; substitutions are not permitted.

a. Taylor Clay Products: taylorclaybrick.com.

2. ASTM C216, Grade SW, Type: FBX.

3. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long (Modular).

4. Color: Shade 320.

5. Texture: Velour.

D. Concrete Masonry Units: ASTM C90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.

2. Weight Classification: Normal weight.

3. Size: Nominal face dimension of 16 inches long x 8 inches high (15-5/8 inches x 7-5/8 inches actual) x 3/8 inch less than nominal widths indicated on Drawings.

E. Mortar shall consist of Portland Cement, ASTM C150, Type 1; Hydrated Lime, ASTM C207, Type S; Aggregate ASTM C144 and potable water.

1. Mortar Types:

a. Use Type M mortar for masonry below grade or in contact with earth.

b. Use Type S mortar for above grade exterior and interior masonry and reinforced masonry.

c. Use Type N mortar for above grade intyerior non-bearing masonry.

2. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent.

a. Products: Subject to compliance with requirements, provide one of the following:

1. BASF Corp.; MasterPel 210MA: www.master-builders-solutions.basf.us.

2. Euclid Chemical Company (The); an RPM company; Blocktite Mortar Admixture: www.euclidchemical.com.

3. GCP Applied Technologies Inc.; Dry-Block Mortar Admixture: www.gcpat.com.

F. Cavity Wall Insulation: Extruded polystyrene (XPS) cavity wall insulation board, complying with ASTM C578, and manufactured using carbon black technology.

1. Type and Compressive Resistance: Type IV, 25 psi, minimum.

2. Thermal Resistance, R-value: 5.6, minimum, per 1 inch thickness at 75 degrees F mean temperature.

3. Insulation Thickness: As indicated on Drawings.

4. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company; Styrofoam Cavitymate Ultra: www.dow.com/en-us/building.

b. Owens Corning; Foamular High-R CW Plus: www.owenscorning.com.

G. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 220 Ladder-Mesh.

H. Masonry-Joint Reinforcement for Composite Masonry: Ladder design with three horizontal rods; one rod at each face shell of backing wythe and with one rod at facing wythe. Size reinforcement to extend at least halfway through facing wythe but with at least 5/8-inch on outside face.

1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 230 Ladder Tri-Mesh.

I. Masonry-Joint Reinforcement for Multiwythe Masonry: Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 270 Ladder LOX-ALL Adjustable Eye Wire with 2X-HOOK.

J. Self-Adhering Stainless Steel Flashing (Self-Adhering Flexible Flashing):

1. Stainless steel sheet, ASTM A240, Type 304, 2 mils thick, minimum; optionally bonded to polymeric fabric as standard with manufacturer. Flashing shall be self-adhering using a butyl adhesive or permanent clear adhesive, with release liner, 10 mils thick, bonded to back of stainless steel sheet or polymeric fabric.

    a. Products: Subject to compliance with requirements, provide one of the following products:

        1. Hohmann & Barnard, Inc.; Mighty-Flash SA: www.h-b.com.

        2. Wire-Bond; Bond-N-Flash SA: www.wirebond.com.

        3. York Manufacturing, Inc.; York 304 SA: www.yorkmfg.com.

K. Factory-Fabricated Inside and Outside Flashing Corners and End Dams: Stainless steel.

1. Manufacturer shall be the same as self-adhering flexible flashing manufacturer.

L. Termination Bars: Stainless steel, 1/8 inch thick by 1-1/2 inch high with 3/8 inch sealant flange at top; compatible with flashing membrane and adhesives.

M. Weep Inserts: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; www.h-b.com; QV Quadro-Vent or a comparable product by one of the following:

    a. Advanced Building Products Inc.; www.advancedbuildingproducts.com.

    b. Heckmann Building Products; www.heckmannbuildingprods.com.

    c. Mortar Net Solutions; www.mortarnet.com.

    d. Wire-Bond; www.wirebond.com.

N. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Configuration: Strips, full depth of cavity and 10 inches high, with dovetail-shaped notches 7 inches deep that prevent clogging with mortar droppings.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Hohmann & Barnard, Inc.; www.h-b.com; Mortar Trap or a comparable product by one of the following:

    a. Advanced Building Products Inc.; www.advancedbuildingproducts.com.

    b. Heckmann Building Products; www.heckmannbuildingprods.com.

    c. Mortar Net Solutions; www.mortarnet.com.

    d. Wire-Bond; www.wirebond.com.

Section 04 7200- Cast Stone

A. Cast Stone Units: Comply with ASTM C1364.

1. Units shall be manufactured using the manufacturer's selected method, vibrant dry tamp (VDT) or wet cast.

2. Water Repellent Admixture: Add to mixes for units exposed to the exterior.

3. Air-Entraining Admixture: Add to mixes for units exposed to the exterior.

4. Shapes, Sizes, and Profiles: As indicated on Drawings.

5. Colors and Textures: As selected by Architect from manufacturer's full range.

B. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240, ASTM A276, or ASTM A666.

C. Dowels: 1/2-inch diameter round bars, fabricated from Type 304 stainless steel complying with ASTM A240/, ASTM A276, or ASTM A666.

D. Refer to Section 04 2000 - Unit Masonry, for mortar.

1. Provide mortar with a water repellent admixture for units exposed to the exterior:

2. Use Type N mortar.

E. Pointing Joints with Sealant:

1. Rake out the following joints for pointing with sealant

a. Head joints in top courses, including copings, parapets, cornices, sills, and steps.

b. Joints in projecting units.

2. Point joints with sealant to comply with applicable requirements in Section 07 9200 - Joint Sealants.

DIVISION 05 - METALS

Section 05 4000 - Cold-Formed Metal Framing

A. Manufacturer's standard load-bearing steel studs complete with runners, blocking, clip angles, shoes, reinforcements, fasteners and accessories.

B. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: ST33H but not less than as required by structural performance requirements.

C. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (16 gage).

2. Minimum Flange Width: 1-5/8 inches.

D. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.

2. Minimum Flange Width: 1-1/2 inches.

E. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.

2. Bracing and bridging.

3. Web stiffeners.

4. Miscellaneous Clips.

5. Backer plates.

6. And other miscellaneous items required for a complete installation.

Section 05 5000 - Metal Fabrications

A. This Section includes the following:

1. Steel framing and supports for mechanical and electrical equipment.

2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

3. Loose steel lintels.

4. Bent metal restraints at top of interior concrete masonry walls.

B. Steel plates, shapes, and bars shall comply with ASTM A36.

C. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

1. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

2. Galvanize miscellaneous framing and supports on exterior of building.

3. Prime interior miscellaneous framing and supports.

D. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

1. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

2. Galvanize loose steel lintels located in exterior walls.

E. Bent Metal Restraints: Provide bent metal restraints to restrain top of masonry walls

1. Fabricate bent metal restraints from 12 gage galvanized sheet steel.

2. Provide bent metal restraints 4 inches long, spaced at 2'-0" o.c., staggered each side of wall.

F. Galvanize all exterior miscellaneous iron fabrications, items built into exterior walls and interior items exposed to high humidity, prime paint all other miscellaneous metal fabrications.

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

Section 06 1000 - Rough Carpentry

A. Furnishing and installation of rough dimensioned items such as:

1. Miscellaneous lumber.

2. Miscellaneous panels and sheathing.

3. Plywood backing panels.

B. Miscellaneous Lumber

1. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

a. Miscellaneous Framing, Blocking, Furring and Nailers

2. Dimension Lumber Items:

a. Species: Provide one of the following:

1. Southern pine or mixed southern pine; SPIB.

2. Spruce-pine-fir; NLGA.

3. Hem-fir; WCLIB, or WWPA

3. Grade: No. 2 or as follows:

a. Standard Grade, provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

C. Miscellaneous Panels and Sheathing:

1. Plywood Concealed from View and Part of Exterior Enclosure: DOC PS 1, Exposure 1, Grade C-D.

2. Concealed Plywood at Interior Locations: DOC PS 1, Exposure 2, Grade C-D.

D. Plywood Backing Panels:

1. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

E. Preservative Treatment Lumber and Plywood: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Application: Treat items indicated on Drawings, and the following:

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

1. At Contractor's option, roof nailers may be non-preservative treated.

b. Plywood and other wood paneling in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing

c. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.

d. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

e. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.

f. Wood floor plates that are installed over concrete slabs-on-grade.

g. Other items as indicated on Drawings.

F. Fire-Retardant-Treated Lumber and Plywood: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.

3. Application: Treat items indicated on Drawings, and the following:

a. All interior rough carpentry items unless otherwise indicated.

b. Other items as indicated on Drawings.

Section 06 4023 - Interior Architectural Woodwork

A. Quality Standard: Comply with "Architectural Woodwork Standards" adopted and published jointly by Architectural Woodwork Institute, Architectural Woodwork Manufacturers Association of Canada and Woodwork Institute, for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

B. Plastic-Laminate Millwork:

1. Quality Standard: Comply with AWS Section 10 “Casework” requirements for laminate cabinets.

2. Grade: Premium.

3. AWI Type of Cabinet Construction: Flush overlay.

4. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

   a. Horizontal Surfaces Other Than Tops: HGL.

   b. Vertical Surfaces: VGS.

   c. Edges: PVC tape, 3 mm thick, matching laminate in color, pattern, and finish.

   d. Manufacturers: Subject to compliance with requirements, provide products as indicated in Color Codes on Drawings. Substitutions not permitted.

   e. Colors, Patterns, and Finishes: As indicated in Color Codes on Drawings

5. Materials for Semiexposed Surfaces: Grade CLS laminate. Color to be white.

C. Solid-Surfacing and Quartz Material Countertops and Window Stools:

1. Quality Standard: Comply with AWI Section 11 “Countertops” requirements for countertops.

2. Grade: Premium.

3. Manufacturers: Subject to compliance with requirements, provide products as indicated in Color Codes on Drawings. Substitutions not permitted.

4. Colors, Patterns, and Finishes: As indicated in Color Codes on Drawings.

DIVISION 07 - THERMAL & MOISTURE PROTECTION

Section 07 1113 - Bituminous Dampproofing

A. Products: Subject to compliance with requirements, provide one or more of the following products:

1. BASF Corp., Master Builders Solutions; Masterseal 610: www.master-builders-solutions.basf.us.

2. BASF Corp., Master Builders Solutions; Masterseal 615: www.master-builders-solutions.basf.us.

3. The Euclid Chemical Company; Dehydratine 75: www.euclidchemical.com.

4. Henry, a Carlisle Company.; Non-Fibered Asphalt Emulsion Dampproofing 788: www.henry.com.

5. Henry, a Carlisle Company.; HE789 FIB Asphalt Emulsion Dampproofing: www.henry.com.

6. Karnak Corp.; 100 Non-fibrated Emulsion Dampproofing: www.karnakcorp.com.

7. Karnak Corp.; 220 Fibered Emulsion Dampproofing: www.karnakcorp.com.

8. W. R. Meadows, Inc.; Sealmastic Type I: www.wrmeadows.com.

9. W. R. Meadows, Inc.; Sealmastic Type II: www.wrmeadows.com.

B. Bituminous Dampproofing: Cold-applied asphalt emulsion.

1. Vertical Application: Comply with ASTM D1227 Type III or ASTM D1187 Type I, Class 1.

a. Brush or spray-applied.

2. Horizontal and Low-Slope Applications: Comply with ASTM D1227 Type II or III, Class 1.

a. Brush or spray-applied.

Section 07 2700 – Fluid-Applied Membrane Air Barriers

A. Section Includes:

1. Vapor-permeable, fluid-applied air barriers.

B. Vapor Permeable Air Barrier Membrane, Fluid-Applied: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils (0.9 mm) or thicker.

1. Physical and Performance Properties:

a. Dry Film Thickness: As recommended by weather barrier manufacturer.

b. Water Penetration: No water penetration at 6.24 psf per ASTM E331.

c. Water Vapor Permeance: 15 perms, maximum; ASTM E96/E96M, Method B.

d. Air Permeance: 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft.; ASTM E2178.

e. Elongation: 250 percent, minimum; ASTM D412.

f. Tensile Strength: 100 psi, minimum; ASTM D412.

g. Flame Spread Index: Less than 25, Class A; ASTM E84.

h. Smoke Developed Index: Less than 450, Class A; ASTM E84.

i. Nail Sealability: Pass, no leakage; ASTM D1970/D1970M.

2. Products: Subject to compliance with requirements, provide one of the following:

a. BASF; MasterSeal AWB 660: www.master-builders-solutions.basf.us

b. Carlisle Coatings & Waterproofing; Fire Resist Barritech VP: www.carlisleccw.com.

c. GCP Applied Technologies; Perm-a-Barrier VPL: www.gcpat.com.

d. Henry Company; Air-Bloc 17MR: www.henry.com.

e. Polyguard; Airlok Flex VP: www.polyguardproducts.com.

f. Prosoco Inc.; R-Guard Spray Wrap MVP: www.prosoco.com.

g. Sto Corp.; StoGuard AirSeal: www.stocorp.com.

h. Tremco Inc.; EXOAIR 230: www.tremcosealants.com.

i. W.R. Meadows; Air-Shield LMP: www.wrmeadows.com.

C. Accessory Materials:

1. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

Section 07 2100 – Thermal Insulation

A. Blanket Insulation - Mineral-Wool:

1. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

a. Thermal Resistance: R-value of 3.7 per inch.

b. Thickness: As indicated on Drawings.

c. Products: Subject to compliance with requirements, provide one of the following:

1. Johns Manville; Mineral Wool Sound Attenuation Fire Batts (SAFB): www.jm.com.

2. Rockwool; Comfortbatt: www.rockwool.com.

3. Thermafiber Inc., an Owens Corning Company; UltraBatt: www.owenscorning.com.

Section 07 2423 – Direct-Applied Finish Systems

A. Section includes:

1. Direct-Applied Finish System (DAFS) for exterior and interior soffits and ceilings (synthetic plaster).

B. Products: Subject to compliance with requirements, provide one of the following:

1. BASF Corp.; Synergy Direct Finish Systems for Soffits and Ceilings: www.basf.com.

2. Dryvit Systems, Inc.; Direct Applied TAFs: www.dryvit.com.

3. Parex USA, Inc.; ACF Soffit: www.parex.com.

4. Sto Corp.; Or Equal: www.stocorp.com.

C. DAFS Materials

1. Top Coat (Finish Coating): Water-based, air curing, acrylic or polymer-based finish with integral color and texture.

a. Texture: Sand/Fine.

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

2. Base Coat: Acrylic- or polymer-modified, fiber reinforced Portland cement coating; compatible with substrate board and reinforcing mesh.

3. Portland Cement: ASTM C150/C150M, Type I or II.

4. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other DAFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. according to ASTM E2098/E2098M and the following:

   a. Weight: Not less than 4.0 oz./sq. yd.

5. Trim Accessories:

   a. General: Types and profiles as designated or required to suit conditions indicated and to comply with DAFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D1784 and ASTM C1063.

Section 07 4213– Formed Metal Wall Panels

A. Section Includes:

1. Formed metal wall panels.

B. Flush-Profile, Concealed-Fastener Metal Wall Panels: Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Centria; IW-10A: www.centria.com or a comparable product by one of the following:

   a. AEP Span; Flush Panel www.aepspan.com.

   b. Berridge Manufacturing Company; FW-12: www.berridge.com.

   c. Fabral; 12-RO: www.fabral.com.

   d. Metal Sales Manufacturing Corp.; Flush Face Series-12, TLC-1: www.metalsales.us.com.

   e. Morin Corp., a Kingspan Group Company; Concealed A-12: www.morincorp.com.

   f. Petersen Aluminum Corporation; Flush Wall Panel: www.pac-clad.com.

2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755.

   a. Nominal Thickness: 0.040 inch (20 gage).

   b. Exterior Finish: High-performance organic finish.

      1. Color: Centria, 9946 Silversmith.

   c. Panel Coverage: 12 inches.

   d. Panel Depth: 1 to 1-1/2 inches.

Section 07 5300 – EPDM Membrane Roofing

A. Single-ply membrane roofing assembly consisting of the following:

1. EPDM single-ply roof membrane; fully adhered.

2. Cover board; fully adhered.

3. Insulation, including tappered insulation; first layer mechanically fastened, all subsequent layers fully adhered.

4. Walkway pads.

B. Manufacturer: Subject to compliance with requirements, provide roof assemblies from one of the following:

1. Carlisle SynTec Systems; www.carlislesyntec.com.

2. Holcim/Elevate (formerly Firestone Building Products); www.holcimelevate.com.

3. Johns Manville; www.jm.com.

C. EPDM Sheet: ASTM D4637, Type II, scrim or fabric internally reinforced, EPDM sheet with factory-applied seam tape.

1. Thickness: 60 mils, nominal.

2. Exposed Face Color: Black.

D. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, glass-fiber reinforced felt facer on both major surfaces.

1. Compressive Strength: 20 psi.

2. Long Term Thermal Resistance (LTTR) R-value: At 1 inch thick; 5.7 at 75 degrees F.

3. Minimum Layers of Insulation: Two.

4. Minimum R-value: 30.

5. Tapered Insulation: Use to create roof slopes not less than 1/4 inch per foot; unless otherwise indicated.

E. Roof Insulation: Polyisocyanurate Board Insulation, ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.

1. Roof insulation shall have a maximum flame spread of 25 and shall be 6 inches thick overall installed in at least two layers.

2. Tapered insulation shall be tapered isocyanurate foam installed over base layers.

F. Cover Board: ASTM C1177, glass-mat, water-resistant gypsum board.

1. Thickness: 1/2 inch.

2. Products: Subject to compliance with requirements, provide one of the following

a. Georgia-Pacific Gypsum: DensDeck Prime Roof Board: www. gp. com.

b. National Gypsum Company; DEXcell Brand FA Glass Mat Roof Board: www. nationalgypsum. com.

c. United States Gypsum Co.; USG Securock Brand Ultralight Coated Glas-Mat Roof Board; www. usg. com.

G. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls.

1. Pad Size: 30 by 30 inches.

2. Thickness: 0.30 inch, minimum.

3. Color: Black.

Section 07 6200 - Sheet Metal Flashing and Trim

A. This Section includes the following sheet metal flashing and trim:

B. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable.

C. Materials:

1. Stainless steel, AISI Type 302/304, ASTM A167, 2D annealed finish, dead soft.

2. Prefinished Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

a. Exposed Coil-Coated Finish:

1. Fluoropolymer AAMA 2605. 2 or 3-coat system. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a) Colors: Custom colors to match adjacent metal finishes; otherwise custom colors to match Architect’s samples.

D. Provide stainless steel flashings in areas concealed from public view.

E. Provide prefinished aluminum flashings in areas exposed to public view.

F. Provide prefinished aluminum flashings in areas exposed to public view.

Section 07 7100 – Manufactured Roof Specialties

A. This Section includes the following manufactured roof specialties:

1. Copings.

2. Fascia/Gravel Stop.

B. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Architectural Products Co.; AP Snap Tight Coping: www.archprod.com.

b. ATAS International, Inc.; Rapid-Lok Coping: www.atas.com.

c. Carlisle SynTec Systems; SecureEdge 200 Coping: www. carlislesyntec. com.

d. Holcim/Elevate (formerly Firestone Building Products); Firestone Gold Coping: www.holcimelevate.com.

e. Hickman Edge Systems, LLC; PermaSnap Premier: www.hickmanedgesystems.com.

f. Johns Manville; Presto Lock Coping System: www.jm.com.

g. Metal-Era; Perma-Tite Coping: www.metalera.com.

h. Petersen Aluminum Corp.; PAC-TITE Coping: www.pac-clad.com.

2. Formed Aluminum Sheet Coping Caps: Aluminum sheet, 0.063 inch thick.

3. Corners: Factory mitered and continuously welded.

4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

5. Finish:

a. Finish: Fluoropolymer.

1. Color: Custom color to match Architect’s sample.

C. Canted Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet and a continuous formed galvanized-steel sheet cant, 0.028 inch thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Architectural Products Co.; AP Snap-On Fascia: www.archprod.com.

b. ATAS International, Inc.; Edge-Lok 2: www.atas.com.

c. Carlisle SynTec Systems; SecureEdge 200 Fascia: www.carlislesyntec.com.

d. Holcim/Elevate (formerly Firestone Building Products); Firestone EdgeGard - Snap-On: www.holcimelevate.com.

e. Hickman Edge Systems, LLC; EconoSnap Fascia: www.hickmanedgesystems.com.

f. Johns Manville; Presto-Tite Edge One Fascia System: www jm.com.

g. Metal-Era; Perma-Tite System 200 Fascia: www.metalera.com.

h. Petersen Aluminum Corp.; PAC Snap Edge Fascia: www.pac-clad.com.

2. Formed Aluminum Sheet Fascia Covers: Aluminum sheet, 0.050 inch thick.

3. Fascia Extension: Fascia extenders with continuous hold-down cleats.

a. Depth: As indicated on Drawings.

4. Finish:

a. Finish: Fluoropolymer.

1. Color: Custom color to match Architect's sample.

Section 07 8413 –Firestopping

A. This Section includes:

1. Firestopping of penetrations.

2. Firestopping of joints.

3. Section includes firestopping of joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on Drawings or not, and other openings, joints, and construction indicated.

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

1. 3M Fire Protection Systems; www.3m.com.

2. A/D Fire Protection Systems; www.adfire.com.

3. Hilti Firestop; www.hilti.com.

4. RectorSeal Firestop; www.rectorseal.com.

5. Specified Technologies, Inc. (STI); www.stifirestop.com.

6. Tremco Fire Protection Systems; www.tremcofirestop.com.

C. Provide firestopping assemblies indicated, or, if not indicated, as required to comply with fire ratings indicated.

1. Fire Ratings: As indicated on Drawings.

D. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

E. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

Section 07 9200 - Joint Sealants

A. This Section includes:

1. Silicone joint sealants.

2. Latex joint sealants.

3. Joint backings and accessories.

B. Manufacturers:

1. Dow Corning Corporation: www.dow.com.

2. Momentive Performance Materials, Inc./GE: www.siliconeforbuilding.com.

3. Pecora Corporation: www.pecora.com.

4. Sika Corporation: www.usa.sika.com.

5. Tremco, Inc.www.tremcosealants.com.

C. United States Gypsum Co.: www.usg.com.

D. Silicone, Nonstaining:

1. ASTM C920, Type S, Grade NS, Class 50; Uses NT, A, G, M and O.

E. Silicone, Traffic Grade:

1. ASTM C920, Type S, Grade NS, Class 100/50; Uses T, M, and O.

F. Silicone, Mildew-Resistant:

1. ASTM C920, Type S, Grade NS, Class 25; Uses NT, A, G, and O.

G. Acrylic Latex:

H. Acrylic latex or siliconized acrylic latex

I. ASTM C834, Type OP, Grade NF or Minus 18 Degrees C (0 Degrees F).

J. Acrylic Latex, Acoustical Sealant:

K. Nonsag, paintable, nonstaining latex sealant. Reduces airborne sound transmission through perimeter joints and openings in wall assemblies.

L. ASTM C834

DIVISION 08 - OPENINGS

Section 08 1113 – Hollow Metal Frames

A. This Section includes:

1. Hollow metal frames.

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

1. Ceco Door, an Assa Abloy Group company: www.cecodoor.com.

2. Curries, an Assa Abloy Group company: www.curries.com.

3. Pioneer Industries, an Assa Abloy Group company: www.pioneerindustries.com.

4. Republic Doors, an Allegion brand: www.republicdoor.com.

5. Steelcraft, an Allegion brand: www.allegion.com.

C. Interior Heavy-Duty Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.

1. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (16 gage).

b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.

c. Construction: Full profile welded.

2. Exposed Finish: Prime.

D. Exterior Extra-Heavy-Duty Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (16 gage), with minimum A60 (ZF180) coating.

b. Construction: Full profile welded.

2. Exposed Finish: Prime.

E. Borrowed Lites

1. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch (16 gage).

2. Where indicated on Drawings borrowed lites shall comply with performance requirements of Fire-Rated, Borrowed-Lite Assemblies.

3. Construction: Full profile welded.

Section 08 1416 - Flush Wood Doors

A. This Section includes the following:

1. Flush wood doors.

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

1. Eggers Industries, acquired by VT Industries, Inc. : www.eggersindustries.com.

2. Five Lakes Manufacturing: www.fivelakesmfg.com

3. Graham Wood Doors; Masonite Architectural: www.graham-maiman.masonite.com.

4. Marshfield-Algoma, Masonite Architectural: https://architectural.masonite.com.

5. Mohawk Doors, Masonite Architectural: https://architectural.masonite.com.

6. Oshkosh Door Company: www.oshkoshdoor.com.

7. VT Industries, Inc: www.vtindustries.com.

C. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI's "Architectural Woodwork Standards" or ANSI/WDMA I.S. 1A.

D. Interior Doors, Solid-Core Five-Ply Veneer-Faced:

1. Performance Grade: Comply with the following:

a. Architectural Woodwork Standards Grade: Premium.

b. ANSI/WDMA I.S. 1A Heavy Duty; Premium grade.

2. Faces: Single-ply wood veneer not less than 1/50 inch thick.

a. Species: Select white maple.

b. Cut: Plain sliced (flat sliced).

c. Match between Veneer Leaves: Slip match.

d. Assembly of Veneer Leaves on Door Faces: Center-balance match.

e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.

f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.

g. Transom Match: Continuous match.

h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 06 4023 - Interior Architectural Woordwork.

3. Exposed Vertical and Top Edges: Applied wood edges of same species as faces and covering edges of crossbands - Architectural Woodwork Standards edge Type D.

a. Vertical Edge Bevel: Hinged edge square, and lock edge beveled 1/8 inch in 2 inches.

b. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.

c. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

d. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

1. Screw-Holding Capability: 475 lbf in accordance with WDMA T.M. 10.

4. Core for Non-Fire-Rated Doors:

a. ANSI A208.1, Grade LD-2 particleboard.

1. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware and as follows:

a) 5-inch top-rail blocking, in doors indicated to have closers.

b) 5-inch bottom-rail blocking, in indicated to have protection plates.

b. Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 08 7100 - Door Hardware, and as required to comply with stile and rail widths and light opening sizes indicated on Drawings.

1. For structural-composite-lumber cores:

a) Screw Withdrawal, Door Face: 475 lbf.

b) Screw Withdrawal, Vertical Door Edge: 475 lbf].

5. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.

a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware and as follows:

1. 5-inch top-rail blocking.

2. 5-inch bottom-rail blocking, in doors indicated to have protection plates.

3. 5-inch midrail blocking, in doors indicated to have exit devices or armor plates.

6. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

E. Factory Finishing

1. Comply with referenced quality standard for factory finishing.

a. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

b. Finish faces, all four edges, edges of cutouts, and mortises.

c. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

2. Factory finish doors with transparent finishes.

3. Transparent Finish:

    a. Architectural Woodwork Standards or ANSI/WDMA I.S. 1A Grade: Premium.

    b. Provide one of the following systems:

        1. Conversion Varnish: Architectural Woodwork Standards System-5, Varnish, Conversion or ANSI/WDMA I.S. 1A TR-4 Conversion Varnish

        2. UV Cured Acrylated Epoxy, Polyester or Urethane: Architectural Woodwork Standards System-9, UV Curable, Acrylated Epoxy, Polyester or Urethane or ANSI/WDMA I.S. 1A TR-8 UV Cured Acrylated Polyester/Urethane.

        3. UV Cured, Water Based: Architectural Woodwork Standards System-10, UV Curable, Water Based.

        4. Catalyzed Polyurethane: Architectural Woodwork Standards System-11, Polyurethane, Catalyzed or ANSI/WDMA I.S. 1A TR-6 Catalyzed Polyurethane.

    c. Staining: Match Architect's sample.

    d. Sheen: Satin.

Section 08 3113 – Access Doors and Frames

A. This Section includes:

1. Access doors and frames for walls and ceilings.

B. Access Doors:

1. Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.

    a. Locations: Masonry walls.

    b. Door: Minimum 0.060-inch thick sheet metal, set flush with exposed face flange of frame.

    c. Frame: Minimum 0.060-inch thick sheet metal with 1-1/4-inch wide, surface-mounted trim.

    d. Hinges: Spring-loaded, concealed-pin type.

    e. Latch: Cam latch operated by screwdriver.

2. Flush Access Doors and Frames with Trimless Frames: Fabricated from steel sheet.

    a. Locations: Gypsum board wall and ceiling surfaces.

    b. Door: Minimum 0.060-inch thick sheet metal, set flush with exposed face flange of frame.

    c. Frame: Minimum 0.060-inch thick sheet metal with drywall bead flange.

    d. Hinges: Spring-loaded, concealed-pin type.

    e. Latch: Cam latch operated by screwdriver.

Section 08 4113 – Aluminum-Framed Entrances and Storefronts

A. This Section includes the following:

1. Aluminum-framed storefront systems, including swing doors..

B. Thermally Broken Storefront Products:

1. Basis of Design Product: Subject to compliance with requirements, provide Tubelite Inc, an Apogee Enterprises, Inc. company; 14000 / 14000-I/O Series: www.tubeliteinc.com, or one of the following comparable products:

a. EFCO Corporation, an Apogee Enterprises, Inc. company; Series 433: www.efcocorp.com.

b. Kawneer North American, an Arconic company; Trifab VG 451T Framing System: www.kawneer.com Oldcastle bought Visrtawall

c. Oldcastle BuildingEnvelope; Series 3000 Thermal Multiplane: www.obe.com.

C. Storefront System:

1. Framing Profile: 2 by 4-1/2 inches, nominal.

2. Framing Construction: Thermally broken.

3. Glazing System: Retained mechanically with gaskets on four sides.

4. Glazing Plane: Center-glazed.

5. Finish: High-performance organic finish.

6. Fabrication Method: Field-fabricated stick system.

7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

8. Steel Reinforcement: As required by manufacturer.

D. Swing Doors: Manufacturer’s standard glazed aluminum doors.

1. Style: Wide style.

a. Top Rail: 5 inches wide.

b. Vertical Stiles: 5 inches wide.

c. Bottom Rail: 10 inches wide.

2. Thickness: 1-3/4 inches.

3. Glazing Stops: Square.

4. Finish: Match adjacent aluminum-framed storefront finish.

E. High-Performance Organic Finish, Two or three-Coat PVDF: AAMA 2605. Fluoropolymer finish, with suspended mica or metallic flakes as required for selected color, containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coats and clear topcoat.

1. Color and Gloss: Custom color to match Architect's sample.

Section 08 7100 - Door Hardware

A. Furnish all Door Hardware required.

1. Furnish door hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.

2. Furnish door hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.

3. Provide hardware for fire-rated openings in compliance with NFPA 80 and local building code requirements. Provide only hardware which has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

4. Where emergency exit devices are required on fire-rated doors that carry supplementary marking on the doors UL labels indicating "fire door to be equipped with fire exit hardware," provide UL label on exit devices indicating "Fire Exit Hardware".

B. Hinges: Numbers used are Hager.

1. Furnish hinges of class and size as follows:

a. For doors up to 36" wide, furnish class BB1279 and size 4-1/2 x 4-1/2 inches.

b. For doors 37" through 40" wide, furnish class BB1168 and size 4-1/2 x 4-1/2.

c. For doors over 40", furnish class BB1168 and size 5 x 4-1/2.

2. Products:

a. Ives.

C. Continuous Geared Hinges: 6063-T6 aluminum alloy, anodized finish. Manufacture to template, uncut hinges non-handed, pinless assembly, three interlocking extrusion, full height of door and frame, lubricated polyacetal thrust bearing, fasteners 410 stainless steel plated and hardened. All hinge profiles to be manufactured to template bearing locations, with heavy duty bearing configurations at at 2-9/16” spacing with a minimum of 32 bearings**.**

1. Length: 1" less than door opening height.

2. Furnish at exterior doors.

3. Products:

a. Ives.

b. Select Products, Ltd.

D. Locksets and Latchsets: Mortise type with lever handles.

1. Products:

a. Schlage L Series

2. Lockset Trim:

a. Schlage 06A

E. Exit Devices: Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.

1. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.

2. Exit Devices:

a. Von Duprin 98 Series.

F. Electric Strike:

1. Von Duprin 6000 series

G. Electric Power Transfer:

1. Von Duprin EPT

H. Closers: LCN 4000 Smoothee Series.

1. Surface Mounted: Non-sized, adjustable from size 1 through size 5.

2. Furnish accessories such as drop plates, panel adapters, thick-hub shoes, blade stop spacers and shoe supports as required to install door closers correctly.

I. Kick Plates: Stainless steel, .050 inches thick, 10 inch high x door width less 1-1/2 inch at single doors, and less one (1) inch at pairs.

1. Drill and countersink screw holes for oval head undercut screws. Pan head screws not acceptable.

J. Bumpers: B.H.M.A. L02101. Wrought, forged, or cast, approximately 2-1/2 inch diameter, concave rubber center, concealed fasteners.

K. Thresholds: Furnish one unit or assembly per door opening, at batteries, butted together with only hairline joints.

1. Cope at jambs.

2. Furnish full wall opening width when frames are recessed.

L. Cylinders: Masterkeyed and grandmaster keyed to Owner's system.

Section 08 8000 - Glazing

A. This Section includes:

1. Monolithic glazing.

2. Laminated glazing.

3. Insulating glazing.

4. Miscellaneous glazing materials.

B. Safety glazing, general: Complies with 16 CFR 1201, Category II; laminated or tempered glass.

C. Interior glass in nonfire-rated doors, sidelights, borrowed lights shall be 1/4" clear laminated float glass.

1. Provide safety glazing where required by code.

D. Insulating-Glass Units (Low-E):

1. Basis-of-Design Product: Vitro Architectural Glass (formerly PPG Industries, Inc.): Solarban 70 www.vitroglazings.com, on clear glass or a comparable product by one of the following:

a. Guardian Glass, LLC: www.guardianglass.com.

b. Pilkington North America Inc: www.pilkington.com.

c. Viracon, Inc: www.viracon.com.

d. Vitro Architectural Glass (formerly PPG Industries, Inc.): www.vitroglazings.com.

2. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm (1 inch and 1/4 inch nominal).

3. Interspace Content: Argon.

4. Outdoor Lite: Class 1 (clear) float glass.

5. Indoor Lite: Class 1 (clear) float glass.

6. Low-E coating on Number 2 surface.

7. Provide Kind HS (heat strengthened) or Kind FT (fully tempered) as recommended by inuslating unit fabricator.

8. Provide safety glazing (laminated or tempered) where required by code.

E. Spandrel glass units shall be 1 inch insulating units as follows:

1. Insulating glass unit as specified above with the following:

a. Ceramic or silicone coating on Number 4 surface.

2. Provide safety glazing where required by code.

DIVISION 09 - FINISHES

Section 09 2216 – Non-Structural Steel Framing

A. This Section includes the following:

1. Non-load-bearing steel framing.

B. Steel Partition And Soffit Framing:

1. Comply with ASTM C 754 for conditions indicated.

2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653, G40, hot-dip galvanized zinc coating.

3. Steel Studs and Runners: ASTM C 645.

a. Minimum Base Metal Thickness: 0.0312 inch, (20 gage) or 20 gage equivalent if using double helix embossed dimpled members.

b. Depth: As indicated.

4. Slotted Deflection Track: Steel sheet top slotted runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.

5. Cold-Rolled Channel Bridging: 0.0538-inch (16 gage) bare steel thickness, with minimum 1/2-inch- wide flange.

a. Depth: 1-1/2 inches.

b. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.

6. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

a. Minimum Base Metal Thickness: 0.0179 inch, (25 gage).

b. Depth: 7/8 inch.

7. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

C. Steel Suspended Ceiling Framing:

1. Hangers: As follows:

a. Wire Hangers: ASTM A 641, Class 1 zinc coating, soft temper, 0.162-inch diameter.

2. Carrying Channels: Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch, (16 gage) a minimum 1/2-inch- wide flange, with manufacturer's standard corrosion-resistant coating.

a. Depth: 1-1/2 inches.

3. Cold Rolled Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange, 3/4 inch deep.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

5. Finish: ASTM A 653, G60 hot-dip galvanized coating.

D. Protective Coatings: Equivalent (EQ) coatings are not acceptable; products shall be hot-dip galvanized as indicated.

E. Embossed (equivalent thickness) steel framing products are not acceptable; products shall be in steel thicknesses indicated.

Section 09 2900- Gypsum Board

A. Section Includes:

1. Interior gypsum board.

2. Tile backing panels.

B. Gypsum Board: ASTM C1396

1. Type X.

2. Thickness: 5/8 inch.

3. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Regular Gypsum Board: www.certainteed.com.

b. Continental Building Products; Regular Drywall: www.continental-bp.com.

c. Georgia-Pacific Gypsum; ToughRock Gypsum Board: www.gp.com.

d. National Gypsum Company; Gold Bond Brand Gypsum Board: www.nationalgypsum.com.

e. USG Corporation; Sheetrock Brand Gypsum Panels: www.usg.com.

C. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178.

1. Thickness: 5/8 inch.

2. Type: Fire resistance rated Type X, UL or WH listed.

3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.

4. Locations: Non-wet areas and elsewhere as indicated on Drawings; including, but not limited to, the following:

a. Kitchens.

b. Laundry areas.

c. Bathrooms.

5. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Diamondback Tile Backer: www.certainteed.com.

b. Georgia-Pacific Gypsum; DensShield Tile Backer: www.gp.com.

c. National Gypsum Company; Gold Bond Brand eXP Tile Backer: www.nationalgypsum.com.

d. USG Corporation; Durock Brand Glass-Mat Tile Backerboard: www.usg.com.

D. Joint Treatment: Comply with ASTM C475 and shall be paper reinforcing tape with single component, multi-purpose grade, ready-mixed, vinyl type joint compound.

E. Trim Accessories: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc**.**

2. Cornerbead: Use at outside corners.

3. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges**.**

4. Control Joints: One-piece-type, folded pair in M-shaped configuration; with removable protective tape on face of control joint.

F. Sound Attenuation Blankets: Semi-rigid mineral fiber complying with FS HH-I-521, Type 1, with Class 25 flame spread equal to USG Sound Attenuation Blankets.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:

1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated.

2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile and where indicated.

3. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.

Section 09 3000 – Tiling

A. Section Includes:

1. Hard tile.

2. Waterproof/crack isolation membrane .

3. Metal edge strips.

B. Tile: Refer to Color Codes on Drawings. Substitutions not permitted.

1. Drawing Designations: FT and WT Series.

2. Grout Colors: As indicated by Room Finish Schedules and Color Codes on Drawings or, if not indicated, standard colors as selected by Architect.

3. Joint Sizes: As recommended by tile manufacturer unless otherwise indicated on Drawings..

C. Waterproofing/Crack-Suuppression Membrane: One of the following types:

1. Fabric-Reinforced, Fluid-Applied Product: System consisting of liquid-latex rubber and fabric reinforcement.

a. Products: Subject to compliance with requirements provide one of the following

1. Bostik, Inc; GoldPlus: www.bostik.com.

2. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane: www.custombuildingproducts.com.

3. LATICRETE International, Inc; Hydro Barrier: www.laticrete.com.

4. MAPEI Corp.; Mapelastic AquaDefense: www.mapei.com.

5. TEC, H.B. Fuller Construction Products Inc; HydraFlex: www.tecspecialty.com.

2. Unreinforced, Fluid-Applied Product: Self-curing liquid rubber polymer in a consistency suitable for brush or roller application and intended for use as waterproofing/anti-fracture membrane.

a. Products: Subject to compliance with requirements provide one of the following

1. Custom Building Products; RedGard: www.custombuildingproducts.com.

2. LATICRETE International, Inc; Hydro Ban: www.laticrete.com.

3. MAPEI Corp.; Mapelastic AquaDefense: www.mapei.com.

D. Setting Materials:

1. Modified Dry-Set Mortar (Thinset): ANSI A118.4 and ANSI A118.11.

a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

b. Products: Subject to compliance with requirements provide one of the following

1. Bostik, Inc; Bostik PM: www.bostik.com.

2. Custom Building Products; VersaBond Flex Professional Thin-Set Mortar: www.custombuildingproducts.com.

3. LATICRETE International, Inc; 253 Gold: www.laticrete.com.

4. MAPEI Corp.; Ultraflex 2: www.mapei.com.

5. TEC, H.B. Fuller Construction Products Inc.; Full Flex Premium Thin Set Mortar: www.tecspecialty.com.

2. Modified Dry-Set Mortar (Medium-bed / Large format tile): ANSI A118.4 and ANSI A118.11.

a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

b. Products: Subject to compliance with requirements provide one of the following

1. Bostik, Inc; Big Tile & Stone: www.bostik.com.

2. Custom Building Products; Natural Stone & Large Tile Premium Mortar: www.custombuildingproducts.com.

3. LATICRETE International, Inc; 4-XLT: www.laticrete.com.

4. MAPEI Corp.; Large Tile & Stone Mortar: www.mapei.com.

5. TEC, H.B. Fuller Construction Products Inc; Ultimate Large Tile Mortar or Ultraflex LFT: www.tecspecialty.com.

E. High Performance Grout: ANSI A118.7 polymer modified cement grout or other high performance formulation.

1. Products: Provide one of the following types:

a. Prepackaged, Dry Mix Grout: High performance cement-based; stain resistant, no sealer required. Subject to compliance with requirements, provide one of the following:

1. Bostik, Inc; Hydroment Vivid: www.bostik.com.

2. Custom Building Products; Prism Ultimate Performance Grout: www.custombuildingproducts.com.

3. LATICRETE International, Inc; Permacolor Select Grout: www.laticrete.com.

4. MAPEI Corp.; Ultracolor Plus FA: www.mapei.com.

5. TEC, H.B. Fuller Construction Products Inc; Power Grout: www.tecspecialty.com.

b. Pre-mixed Single-component Grout: High performance formulation; stain resistant, no sealer required. Subject to compliance with requirements, provide one of the following:

1. Bostik, Inc; TruColor RapidCure: www.bostik.com.

2. Custom Building Products; Fusion Pro Single Grout: www.custombuildingproducts.com.

3. LATICRETE International, Inc; Ready-To_use Grout: www.laticrete.com.

4. MAPEI Corp.; Flexcolor CQ: www.mapei.com.

5. TEC, H.B. Fuller Construction Products Inc; InColor Advanced Performance Grout: www.tecspecialty.com.

F. Installation - Floors - Thin-Set Methods

1. Concrete Substrates - Thinset Installation: Install in accordance with TCNA F122 or F122A as appropriate for substrate conditions.

a. Provide waterproofing and crack isolation membrane.

G. Installation - Wall Tile

1. Concrete and Masonry Substrates – Thinset Installation: Install in accordance with TCNA W202I.

2. Glass-Mat Backing Panel Substrates - Thinset Installation: Install in accordance with TCNA W245.

Section 09 5113 - Acoustical Panel Ceilings

A. Section includes:

1. Acoustical panels.

2. Metal suspension systems.

3. Removal, salvaging, and reinstallation of existing acoustical panel ceilings.

B. Acoustical Panels:

1. Acoustic Panels: The design for each acoustic panel specified is based on the product indicated in Color Codes on Drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

a. Armstrong World Industries, Inc: www.armstrongceilings.com.

b. CertainTeed Corporation: www.certainteed.com.

c. Rockfon North America: www.rockfon.com.

d. USG Corporation: www.usg.com.

C. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635 and designated by type, structural classification, and finish indicated.

1. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.

a. Structural Classification: Intermediate-duty system.

b. Face Design: Flat, flush.

c. Cap Material: Cold-rolled steel or aluminum.

d. Cap Finish: Painted white.

e. Basis-of-Design Product USG Corporation; USG Donn Brand DX: www.usg.com.

D. Removal, Salvaging, and Reinstallation of Existing Acoustical Panel Ceilings:

1. Remove, salvage and reinstall existing acoustical panels ceilings as required to facilitate new construction.

a. Take care not to scratch, chip, gouge, dent or otherwise damage acoustical panel faces or edges.

b. Take care not to scratch, bend, dent, twist, rack or otherwise damage suspension grid members.

c. Safely store removed materials and protect from damage. Store removed materials in location where they will not be damaged by construction operations or vandalism.

2. Modify existing grid system and acoustic panels to accommodate new work.

3. Reinstall according to requirements of this Section.

4. Replace any damaged or missing metal suspension system components with new.

a. Match existing metal suspension system in size, color, and material.

5. Replace any damaged or missing acoustical panels with new.

a. Match existing acoustical panels in size, color, texture, and material.

Section 09 6513 – Resilient Wall Base and Accessories

A. Section includes:

1. Resilient wall base.

2. Resilient molding accessories.

B. Resilient Wall Base: ASTM F 1861.

1. Type (Material Requirement): TS (rubber, vulcanized thermoset) or TP (rubber, thermoplastic).

2. Group (Manufacturing Method): I (solid, homogeneous).

3. Style: Cove (with top-set toe) and Straight where indicated in Room Finish Schedule on Drawings.

4. Height: 4 inches.

5. Corners: Job formed.

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

a. Armstrong Flooring Inc.: www.armstrongflooring.com.

b. Mannington Mills, Inc./Burke Flooring: www.manningtoncommercial.com.

c. Johnsonite, a Tarkett Company: www.johnsonite.com.

d. Nora Systems, Inc.: www.nora.com

e. Roppe Corp: www.roppe.com.

f. Tarkett Company: commercial.tarkett.com.

C. Resilient Molding Accessories

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

a. Armstrong Flooring Inc.: www.armstrongflooring.com.

b. Mannington Mills, Inc./Burke Flooring: www.manningtoncommercial.com.

c. Johnsonite, a Tarkett Company: www.johnsonite.com.

d. Nora Systems, Inc.: www.nora.com

e. Roppe Corp: www.roppe.com.

f. Tarkett Company: commercial.tarkett.com.

2. Resilient edge and transition strips for changes in flooring materials

a. Types:

1. Cap for carpet base.

2. Carpet edge for glue-down applications.

3. Nosing for resilient floor covering.

4. Reducer strip for resilient floor covering.

5. Joiner for tile and carpet.

6. Joiner for resilient flooring and carpet.

b. Material: Rubber.

Section 09 6813 – Tile Carpeting

A. Section Includes:

1. Carpet tile.

B. Carpet Tile: Refer to Color Codes on Drawings. Substitutions not permitted.

1. Drawing Designations: CPT Series.

2. Colors and Patterns:

a. Colors: As indicated in Color Codes on Drawings.

b. Patterns: As indicated on Drawings.

3. Installation Method: As selected by Architect, unless otherwise indicated on Drawings.

Section 09 9100 - Painting

A. Section Includes:

1. Exterior painting.

2. Interior painting.

B. Painting shall include surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Paint exposed surfaces, except where surface or material is not to be painted or is to remain natural.

2. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

3. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

C. Manufacturers:

1. Benjamin Moore: Benjamin Moore & Co.: www: benjaminmoore.com.

2. PPG: PPG Industries, Inc., Architectural Coatings: www.ppgpaints.com.

3. Sherwin-Williams: The Sherwin-Williams Company: www: sherwin-williams.com.

D. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application.

E. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated.

F. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

G. Primers:

1. Concrete Unit Masonry Block Filler: Alkali-resistant acrylic/latex primer, water-based.

2. Ferrous-Metal Primer: Rust-inhibitive acrylic/latex primer, water-based.

3. Galvanized Metal Primer: Rust-inhibitive acrylic/latex primer, water-based.

4. Adhesion Promoting Primer: Acrylic/latex stain-blocking primer/sealer with high adhesion, water-base.

5. Interior Gypsum Board Primer: Acrylic/latex primer, water-based.

H. Exterior Finish Coats:

1. Exterior Metals: Direct-to-metal (DTM) acrylic semi-gloss paint.

I. Interior Finish Coats:

1. Interior Metals: Direct-to-metal (DTM). acrylic semi-gloss enamel paint.

2. Concrete Masonry Units: Acrylic/latex paint, water-based, semi-gloss.

3. Gypsum Board: Acrylic/latex paint, water-based. Flat at ceilings, eggshell at walls.

Section 09 9600 – High Performance Coatings

A. High Performance Coatings: Includes surface preparation and field application of high-performance coating systems to items and surfaces.

1. Paint exposed surfaces, except where surface or material is not to be painted or is to remain natural.

2. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

3. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

B. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application.

C. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated.

D. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

E. Interior Primers:

1. Concrete Unit Masonry Block Filler: Alkali-resistant acrylic/latex primer, water-based.

2. Ferrous-Metal Primer: Rust-inhibitive acrylic/latex primer, water-based.

3. Galvanized Metal Primer: Rust-inhibitive acrylic/latex primer, water-based.

4. Adhesion Promoting Primer: Acrylic/latex stain-blocking primer/sealer with high adhesion, water-base.

5. Interior Gypsum Board Primer: Acrylic/latex primer, water-based.

F. Interior Finish Coats: Single or multi component, waterbased, acrylic epoxy, semi-gloss finish.

DIVISION 10 - SPECIALTIES

Section 10 1100 - Visual Display Boards

A. Markerboards: Porcelain enameled steel face sheet (24 gage) on 3/8 inch thick particleboard core with 0.015 inch aluminum sheet backing.

1. Marker boards shall have manufacturer’s standard light-colored special writing surface with gloss finish intended for use with liquid felt markers.

2. Aluminum frames and trim shall consist of extruded aluminum box-type chalk tray, map rail, and snap-on or slip-on trim without exposed fasteners.

B. Tackboards: Fabric wrapped composition board with flame spread of 25 or less.

Section 10 2800 – Toilet, Bath and Laundry Accessories

A. Section includes:

1. Toilet accessories.

2. Childcare accessories.

3. Custodial accessories.

B. Basis of Design:

1. Toilet Accessories: The design for each item specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

a. American Specialties, Inc, (ASI): www.americanspecialties.com.

b. Bobrick Washroom Equipment, Inc.: www.bobrick.com.

c. Bradley Corporation: www.bradleycorp.com.

2. Childcare Accessories: The design for each item specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

a. American Specialties, Inc, (ASI): www.americanspecialties.com.

b. Bobrick Washroom Equipment, Inc.: www.bobrick.com.

c. Bradley Corporation: www.bradleycorp.com.

d. World Dryer Corp.: www.worlddryer.com.

3. Custodial Accessories: The design for each item specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

a. American Specialties, Inc, (ASI): www.americanspecialties.com.

b. Bobrick Washroom Equipment, Inc.: www.bobrick.com.

c. Bradley Corporation: www.bradleycorp.com.

C. Toilet Paper Dispenser: Owner furnished; Contractor installed.

D. Paper Towel Dispenser: Owner furnished; Contractor installed.

E. Soap Dispenser: Owner furnished; Contractor installed.

F. Sanitary-Napkin and Tampon Vendor: Owner furnished; Contractor installed.

G. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-254.

H. Mirrors:

1. Size: As indicated on Drawings but not less than 18 inches wide by 36 inches high.

2. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-290.

I. Grab Bars:

1. Configuration and Length: As indicated on Drawings.

2. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-6806 Series.

J. Diaper-Changing Station:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; KB200.

K. Combination Utility Shelf and Mop and Broom Holder:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-224.

DIVISION 11 - EQUIPMENT

Not Applicable

DIVISION 12 - FURNISHINGS

Section 12 2413 – Roller Window Shades

A. This Section includes:

1. Manual roller shades.

2. Dual motorized roller shades.

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

1. Draper, Inc: draperinc.com.

2. Hunter Douglas Architectural: hunterdouglasarchitectural.com.

3. MechoShade Systems, LLC: mechoshade.com.

C. Refer to Drawings for roller shade configurations and installation methods, including:

1. Roller shade locations.

2. Manual or motorized operation.

3. Single or double roller configurations.

4. Shadeband materials.

5. Installation methods including front fascias, exposed headboxes, and recessed shade pockets.

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

E. Light-Filtering Fabric –SC Series: Refer to Color Codes on Drawings.

1. Manufacturers: The design for each shadeband material is based on the product indicated in Color Codes on Drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

a. Mermet Corporation: : www.mermetusa.com.

b. Phifer, Inc.: : www.phifer.com

2. Performance Requirements:

   a. UV Blockage: 95 percent, minimum.

   b. Fungal Resistance: No growth when tested according to ASTM G21.

3. Openness Factor: 3 percent.

4. Colors: As indicated in Color Codes and Window Shade Schedule on Drawings.

F. Light-Blocking Fabric –SC Series: Refer to Color Codes on Drawings.

1. Manufacturers: The design for each shadeband material is based on the product indicated in Color Codes on Drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the following:

   a. Mermet Corporation: : www.mermetusa.com.

   b. Phifer, Inc.: : www.phifer.com

2. Performance Requirements:

   a. UV Blockage: 95 percent, minimum.

   b. Fungal Resistance: No growth when tested according to ASTM G21.

3. Openness Factor: 0 percent (Blackout/Room Darkening).

4. Colors: As indicated in Color Codes and Window Shade Schedule on Drawings.

Section 12 3216 – Manufactured Plastic Laminate Clad Casework

A. This Section includes the following:

1. Plastic-laminate-clad casework.

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

1. Advanced Cabinet Systems: www.advancedcabinetsystems.com.

2. Case Systems: www.casesystems.com.

3. Stevens Industries, Inc.: www.stevensind.com.

4. Strata Design; www.stratadesign.com

5. TMI Systems Design Corporation: www.tmisystems.com.

C. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.

1. Grade: Premium.

D. Design: Frameless cabinet construction with the following door and drawer-front style:

1. Flush overlay.

E. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework. Provide casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications

F. Colors and Patterns: As indicated in Color Codes on Drawings.

DIVISION 13 - SPECIAL CONSTRUCTION

Not Applicable

DIVISION 14 - CONVEYING SYSTEMS

Not Applicable

DIVISION 31 - EARTHWORK

Section 31 2000 - Earthwork

A. Excavation, backfill, compaction and grading required for new construction.

B. Soil Erosion and Sedimentation Control: Comply with State of Michigan Soil Erosion and Sedimentation Act of 1972 as amended.

C. Excavation: Is unclassified and includes excavation of earth and other materials encountered to required elevations and extending a sufficient distance to permit placing and removal of concrete formwork, installation of services and other construction and for inspection.

D. Preparation of subgrade for building slabs, walks and pavements.

E. Granular base course for support of building slabs, walks, and concrete pavements, shall comply with MDOT 1990 Standard Specifications for Construction for Class II granular material.

F. Aggregate base course for support of asphalt paving shall conform to MDOT 22A aggregate.

G. Engineered fill shall be granular fill material complying with MDOT Class II in accordance with Table 8.02, except maximum size 1/2”.

H. Compaction: Place and compact soil materials in layers not more than 8" in loose depth for material compacted by heavy equipment and not more than 4" for material compacted by hand-operated mechanical tampers. Compact soil to not less than following percentages of maximum density in accordance with ASTM D1557 (Modified Proctor).

I. Structures, building slabs, pavements: Compact top 12" of subgrade and each layer of backfill or fill material at 95% maximum density.

J. Lawn or unpaved areas: Compact top 6" of subgrade and each layer of backfill or fill material at 85% maximum density.

K. Walks: Compact top 6" of subgrade and each layer of backfill or fill material at 90% maximum density.

L. Grading: Uniformly grade areas, including adjacent transition areas.

1. Grade areas adjacent to building to slope away from structures and prevent ponding.

END OF ARCHITECTURAL OUTLINE SPECIFICATIONS

SECTION 20 0500 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Bidding and Contracting Requirements, and Division 01 General Requirements Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. References
2. Quality Assurance
3. System Description
4. Permits and Fees
5. Examination of Drawings and Premises
6. Substitutions
7. Work Under Other Contracts
8. Submittals
9. Work Restrictions, Coordination, Sequencing and Scheduling
10. Conflicting Requirements and Minor Changes in the Work
11. Delivery, Storage and Handling
12. Basic Electrical Requirements and Methods
13. Interoperability
14. Warranties
15. Mechanical Equipment -General
16. Sealing of Openings (Firestopping)
17. Examination of Existing Conditions and Temporary Services
18. Mechanical Demolition Work
19. Cutting and Patching
20. Protection of Installed Construction, Damage to Other Work and Corrections
21. Chases and Recesses
22. Concrete Work, Equipment Foundations and Supports
23. Coordination with Other Trades
24. Assembly of Equipment, Equipment Connections, Installation and Lubrication
25. Touch-up Painting
26. Scaffolding, Rigging, Hoisting, Excavation and Backfilling
27. Accessibility and Access Panels
28. Field Quality Control, Starting, Adjusting and Commissioning
29. Training and Instruction Program
30. Cleaning and Waste Management

1.3 REFERENCES

A. The mechanical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. AABC - Associated Air Balance Council
2. ANSI - American National Standards Institute
3. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
4. ASTM - American Society for Testing Materials
5. NEC - National Electrical Code
6. NFPA - National Fire Protection Association
7. NEMA - National Electrical Manufacturer’s Association
8. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
9. UL - Underwriters’ Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.

B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.

C. Regulatory Requirements:

1. Ordinances and Codes: Perform all work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

    a. Notify the Architect/Engineer before submitting his proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.
    b. Barrier-Free Regulations: Comply with the requirements of the State of Michigan Handicapped Barrier-Free Regulations and with the Americans with Disabilities Act (ADA).

D. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.

E. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.

F. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

G. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.

H. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

I. Associated Services: Cooperate with agencies performing required commissioning, tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.

4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

J. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

K. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect/Engineer will determine which products shall be used at no additional cost to the project.

L. Acceptance of Work: Failure on the part of the A/E to reject shop drawings or to reject Work in progress shall not be interpreted as acceptance of Work not in conformance with Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

1.5 SYSTEM DESCRIPTION

A. Design Requirements: Furnish all labor, materials, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified in the Division 20, 21, 22 and 23 Sections and as indicated on Drawings.

1. The Mechanical Drawings indicate the general design and extent of all equipment, piping and ductwork. Comply with the Drawings as closely as actual construction of the building and the work of other trades permit.

1.6 PERMITS AND FEES

A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of work and expenses for permits, licenses, tests and inspections. File all necessary drawings, prepare all documents and obtain all necessary approvals of all governmental and state departments having jurisdiction, obtain all required certificates of inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

1. Upon completion of the Work, obtain and send certificates of inspections and approvals to the Architect/Engineer.

1.7 EXAMINATION OF DRAWINGS AND PREMISES

A. Before submitting Bids, examine the architectural, electrical and other trades' drawings and specifications.

1. Notify Architect/Engineer should any discrepancies occur between them and the mechanical work.
2. No additional charges will be allowed because of failure to make this examination, or to include all materials and labor required for the Work.
3. Before submitting Bids, examine the premises to determine existing conditions for performing the Work. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.
4. The Architectural Drawings take precedence in all matters pertaining to the building structure, Mechanical drawings in all matters pertaining to Mechanical trades and Electrical drawings in all

matters pertaining to Electrical trades installation. However, where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer who shall determine the course of action to be taken.

B. Field Measurements:

1. Drawings are not intended to be scaled for roughing-in or to serve as shop drawings. Take all field measurements required for fitting the installation to the building.

1.8 SUBSTITUTIONS

A. Base Bid must be in accordance with materials or products specified. Any exceptions to this must be approved in writing by the Architect/Engineer ten (10) days or more prior to bidding.

1. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the Bid, but will not affect the awarding of the Contract.
2. Mandatory Alternates: The Contractor shall refer to alternates listed in Division 01 and proposals shall submit price quotations for the alternates that apply to the mechanical work.

1.9 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

B. This Contractor shall be responsible for coordination with piping, equipment, etc., installed in previous Bid Packages. The Contractor shall review the previous bid package drawings and specifications and shall visit the site as part of his/her coordination effort. The Contractor shall also review with the Architect/Engineer, any piping, equipment, and devices that are shown on Bid Package documents but have been purchased and installed under previous bid packages.

1.10 SUBMITTALS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.

2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Substitutions: Not allowed.

C. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

D. Conditions for Consideration: Architect/Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect/Engineer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of Architect/Engineers and owners, if requested.
5. Samples, if requested.

E. Product List: Submit a list, in tabular from, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.

1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.

F. Delegated-Design Services:

1. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of the Contractor by the Contract Documents, the Contractor shall provide products and systems complying with specific performance and design indicated.

    a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Architect.

2. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file copies of certificate, signed and sealed by the responsible design professional registered in the State where the project is located, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional.

    a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

G. Submittal Requirements:

1. The following is in addition to the requirements for submittals in Division 01
2. Material List: Submit a complete list of all materials and equipment, and their manufacturers, for approval by the Architect/Engineer within 15 days after award of contract and prior to submittal of shop drawings.
3. All equipment of the same or similar systems shall be by the same manufacturer

4. Shop Drawings: Prepare shop drawings drawn to scale and submit to the Architect/Engineer for review, following submittal requirements listed in Division 01 and as required by the General Conditions. After the shop drawings are reviewed, they will be stamped and returned for distribution.
5. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional Architect/Engineer if specified.

6. Submit shop drawings of all sheet metal ductwork with necessary sections, details, dimensions, etc.

    a. All sheet metal shop drawings shall bear balance agency approval stamp prior to submittal to Architect/Engineer.

7. Submit shop drawings and product data for all equipment, materials, valves, plumbing and heating specialties, pipe hangers, wiring diagrams and control diagrams including but not limited to items indicated below.
8. No apparatus or equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
9. Submit shop drawing with all pertinent data and with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.
10. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.
11. Where the shop drawings consist of manufacturer's standard detail drawing or schedules and contain data for a variety of similar equipment, indicate the data pertinent to the equipment furnished for this project only. Standard detail drawings and schedules not clearly indicating which data is associated with this Project shall be returned "Rejected”.
12. Where accessories and/or options are specified and do not appear as part of manufacturer's standard detail drawings, state each accessory that is to be provided with the equipment on the standard detail drawings.
13. Partial submittals for equipment will not be permitted. Where partial submittals are transmitted to the Architect/Engineer, they will be returned "Rejected”.
14. Plumbing fixture submittals shall be submitted as one (1) package including all fixtures intended to be used for this Project.
15. Submittal Preparation: Shop drawing shall be submitted using the IDS “Submittal Form”. Provide one (1) form for each project manual section number. The mechanical contractor shall fill out each submittal following the instructions printed on the back of the submittal form.
16. Submit manufacturer’s submittals on all major mechanical systems and/or equipment, including but not limited to all equipment scheduled on drawings and all equipment in all division 20, 21, 22 and 23 specifications.

1.11 WORK RESTRICTIONS, COORDINATION, SEQUENCING AND SCHEDULING

A. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services:

1. Notify Owner and Architect/Engineer not less than 10 days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner's and Architect/Engineer's written permission.

B. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

C. Contractor shall coordinate all final specific utility requirements.

D. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the Trades involved.

E. Sequence and schedule work to avoid interference with the work of other Trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

F. Coordinate mechanical equipment installation with other building components.

G. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

H. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

K. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Section 08 3113 “Access Doors and Frames.”

L. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

M. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

1.12 CONFLICTING REQUIREMENTS AND MINOR CHANGES IN THE WORK

A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer to uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect/Engineer for a decision before proceeding.

C. Architect/Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

D. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.

1. A reasonable distance is 15 feet at no additional cost.

1.13 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.

B. Storage and Protection: Provide adequate storage space for all mechanical equipment and materials delivered to the job site under a weather protected enclosure. Location of the space will be designated by the Owner’s Representative. Equipment set in place in unprotected areas must be provided with temporary protection.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic and plastic piping from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.
9. Be responsible for the care and protection of mechanical equipment until it has been fully tested and accepted.
10. Protect materials with permanent factory finish from damage by covering.
11. Protect materials with enamel or glaze surfaces by covering or coating as recommended in “Handling and Care of Enameled Cast Iron Plumbing Fixtures” bulletin, issued by the Plumbing Fixtures Manufacturers Association and as approved.
12. Coat polished or plated metal parts with white petroleum jelly immediately after installation.
13. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
14. Care and protection of electrical equipment furnished by Mechanical Trades and installed by Electrical Trades shall be the responsibility of the Electrical Trades after receiving equipment from Mechanical.

1.14 BASIC ELECTRICAL REQUIREMENTS AND METHODS

A. For Electrical Work provided in Division 20, 21, 22 and 23 Sections, furnish UL Listed components, in accordance with Division 26 and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit. All electrical work provided by this Contractor shall conform to Division 26 requirements.

B. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment specified and scheduled on the Drawings.

1. Where equipment changes are made that involve additional electrical work (larger size motors, additional wiring of equipment, etc.) the Mechanical trades involved shall compensate the electrical trades for the cost of the additional Work required.

C. Heat-producing or spark-generating electrical devices located within Class I, Division I, Group D areas and Class I, Division II, Group D areas shall bear UL Label rated for the exposure.

D. For equipment specified in Divisions 20, 21, 22 and 23 and provided with electrical characteristics requirements other than that specified or indicated, include necessary electrical wiring, components and transformer equipment selected to assure maximum efficiency operation.

E. Provide specialty instrument wiring necessary to operation of a component, assembly or system as part of the work in Divisions 20, 21, 22 and 23.

F. Coordinate the number of auxiliary N.O. and N.C. contacts to be provided as part of the Work to accommodate equipment and functions specified or indicated as part of the work under these Sections.

G. Provide electrical work required for the operation of components and assemblies provided as part of the Work in Division 20, 21, 22 and 23 Sections but not specified or indicated as part of the Work in Division 26.

H. Where “packaged” equipment is specified, one or more power supplies and interconnecting control wiring may be required to provide a complete, operating unit. Any required intercomponent and interassembly power or control wiring shall be provided as part of the Work of Divisions 20, 21, 22 and 23 per the applicable requirements of Division 26.

I. Mount line voltage (120 VAC) control components specified as part of the Work under Division 20, 21, 22 and 23 Sections for connection as part of the work under Division 26.

J. Refer to Electrical Drawings and Division 26 for specific information regarding provisions for and arrangement of electrical circuits and components and for interface with Work specified under Divisions 20, 21, 22 and 23.

1.15 INTEROPERABILITY

A. Contractor shall review all Drawings and Specifications from all Mechanical and Electrical disciplines and shall coordinate work as necessary to ensure proper coordination and interoperability of all existing and new, networked or interconnected systems, as indicated. Networked/interconnected systems may include, but are not limited to the following:

1. DDC controls provided by the Mechanical Systems Controls Contractor
2. Packaged mechanical unit controls provided by the unit Manufacturer
3. Lighting controls provided by the Electrical Contractor
4. Fire Alarm systems provided by the Electrical Contractor
5. Audio/Visual systems provided by the Electrical Contractor
6. Security systems provided by the Electrical Contractor
7. Site central Operator Interface system

1.16 WARRANTIES

A. Warranty: Warranty the mechanical installation to be free from defects and replace or repair, to the satisfaction of the Owner, any part of the mechanical installation which may fail within a period of one year after substantial completion, provided that such failure is due to defects in materials or workmanship or to failure to follow the Contract Documents.

1. File with the Owner any and all warranties from equipment manufacturers and what operating conditions and performance capacities they are based on. Refer to Division 01 Sections.
2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Architect/Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction

B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

C. Warranty Start Date: Date of substantial completion.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT – GENERAL

A. All major items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.

2.2 SEALING OF OPENINGS (FIRESTOPPING)

A. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. (Fiberglass is not acceptable.) Fire and/or smoke barriers shall be UL listed fire and smoke stop fittings and shall have fire rating equal to or greater than the penetrated barrier. Refer to Division 07 Section "Firestop Systems" for additional requirements.

1. Manufacturers:

a. 3M
b. Hilti
c. Tremco
d. Manville

PART 3 - EXECUTION

3.1 EXAMINATION OF EXISTING CONDITIONS AND TEMPORARY SERVICES

A. The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:

a. Description of the Work.
b. List of detrimental conditions, including substrates.
c. List of unacceptable installation tolerances.
d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect/Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

F. Provide temporary water and heat service as described in Division 01.

G. New equipment installed shall not be used for temporary construction use without prior written approval from Owner's representative.

3.2 MECHANICAL DEMOLITION WORK

A. General: Perform mechanical demolition work in a systematic manner. Use such methods as outlined below to complete Work indicated on Drawings.

B. Obtain approval from the Owner prior to interrupting existing services. All service interruptions shall be at a time suitable to the Owner. Where the Owner approves service interruptions at times resulting in premium tile work to this Contractor, this Contractor shall include the premium time in his Base Bid.

C. Remove existing mechanical equipment, components and materials, including but not limited to piping, air handling units, heating units, plumbing fixtures, pumps, supports and other mechanical items made obsolete by the new work.

1. Where existing equipment is removed, piping shall be capped under floor or behind face of wall.

D. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Architect/Engineer, to provided complete and thorough removal of existing work.

E. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

F. Work that has been cut or partially removed shall be protected against damage.

G. Materials salvaged from this work shall not be reused except where reuse is specifically indicated.

H. Existing fixtures and mechanical equipment removed, not reused and not specifically indicated to be turned over to the Owner shall be legally and properly disposed of off Owner's property.

I. Existing fixtures and mechanical equipment specifically indicated to be turned over to the Owner shall be carefully disconnected, removed and turned over to the Owner in a storage area as directed by the Owner.

J. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.

K. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.

L. Remove demolished materials from Project site.

M. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

N. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.

O. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.

P. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.

Q. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.

R. Maintain continuity of all existing MEP devices, and utilization equipment not removed.

S. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.

T. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Architect/Engineer.

U. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

V. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

3.3 CUTTING AND PATCHING

A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.

B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.

C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.

D. The drilling or punching of structural members, such as holes through beams or columns, shall not be done without the specific permission of the Architect/Engineer.

E. Cutting of holes through floors and walls shall be done only at such locations as may be directed by the Architect/Engineer.

F. Cooperate with the other Contractors so that all cutting and repairing in any given area will be done simultaneously.

G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.4 PROTECTION OF INSTALLED CONSTRUCTION, DAMAGE TO OTHER WORK AND CORRECTIONS

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

C. Protect all mechanical equipment, ductwork and piping from dust, dirt and debris throughout construction

D. Remove debris from concealed spaces before enclosing the space.

E. Remove liquid spills promptly.

F. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.

G. Installed Work: Keep installed work clean.

H. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

K. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

L. Mechanical Trades will be responsible for all damage to other Work caused by their Work or through the neglect of their workers.

1. All patching and repairing of any such damaged Work shall be performed by the trades that installed the Work, but the cost shall be paid by the Mechanical Trades.

M. The cost of corrective work shall be included under the contract.

N. Repair or remove and replace defective construction.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

O. Restore permanent facilities used during construction to their specified or original condition.

P. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

Q. Repair components that do not operate properly. Remove and replace operating components to new condition.

R. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

3.5 CHASES AND RECESSES

A. Provide sizes and locations of chases and recesses affecting the mechanical work for provision by general trades.

3.6 CONCRETE WORK, EQUIPMENT FOUNDATIONS AND SUPPORTS

A. Concrete bases shall be provided by Architectural Trades, the correct size and location shall be by Mechanical Trades. Mechanical Trades shall furnish and locate anchor bolts and sleeves, for installation by Architectural Trades.

B. Coordinate with Architectural Trades any concrete work required for the mechanical installation. Concrete work shall include housekeeping pads beneath equipment and vibration isolation bases. Concrete work shall be in conformance with Division 03 Specifications.

C. Furnish foundations and supports for mechanical equipment and materials as required by codes, as listed hereinafter and shown or noted on the Drawings.

D. Provide necessary inserts, rod, structural steel frames, brackets, platforms, etc., for equipment suspended from ceilings or walls.

E. Inserts for equipment support shall be lead shield anchors for small work and expansion shields for large work. Wooden plugs will not be allowed. Do not use metal roof decking and cellular floors for supporting equipment.

3.7 COORDINATION WITH OTHER TRADES

A. Install Work so as to avoid interferences with the Work of other trades. Be responsible for removing and relocating any work that, in the opinion of the Owner’s Representative, causes interferences.

B. Should construction conditions prevent the installation of mechanical equipment at locations shown on the drawings, minor deviations may be permitted and shall be as directed by the Architect/Engineer and shall be made without additional cost to Owner.

3.8 ASSEMBLY OF EQUIPMENT, EQUIPMENT CONNECTIONS, INSTALLATION AND LUBRICATION

A. The Contract Drawings and Specifications indicate items to be purchased and installed which are noted by a manufacturer's name, catalog number and/or brief description.

B. The catalog number may not designate all the accessory parts and appurtenances required for the particular use or function.

C. Arrange with the manufacturer for the purchase of all items required for the complete installation and efficient operation.

D. Connections to equipment, fixtures, etc., shall be made in accordance with the shop drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. Any and all additional connections not shown on the Drawings but called for by the equipment manufacturer's shop drawings or required for the successful operation of the particular equipment furnished shall be installed as part of this Contract at no additional charge to the Owner.

E. All fittings connecting to equipment on piping 2-1/2 inches and above in size, shall be flanged, standard weight pattern with flat machine face provided with ring gaskets.

F. All fittings connecting to equipment on piping 2 inches and below in size, shall be made with unions.

G. All piping connections to pumps and other equipment shall be installed without strain at the pipe connection of the equipment.

1. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

H. Brass couplings shall be used to connect dissimilar metals (such as steel and copper) to prevent electrolytic action.

I. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance as indicated by Architect/Engineer in spaces without a suspended ceiling.

J. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

K. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

L. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

M. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.

N. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

O. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

1. All equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Architect/Engineer and Structural Engineer before installation.
2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect/Engineer and/or to allow for proper access.
3. Allow for building movement, including thermal expansion and contraction.
4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

P. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

Q. Provide all oil for the operation of the equipment until substantial completion. Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. Protect all bearings and shafts during installation and thoroughly grease the steel shafts to prevent corrosion. All motors and other equipment shall be provided with covers as required for proper protection during construction.

3.9 TOUCH-UP PAINTING

A. In general, no painting is required by Mechanical Trades other than touch-up of factory-finished mechanical equipment.

B. All factory finished mechanical equipment shall be cleaned at completion of the job. Equipment showing rust or mars shall be thoroughly cleaned and sanded, prime coated and touched up with enamel of color to match original finish.

3.10 SCAFFOLDING, RIGGING, HOISTING, EXCAVATION AND BACKFILLING

A. Coordinate with Architectural Trades any concrete work required for the mechanical installation. Concrete work shall include housekeeping pads beneath equipment and vibration isolation bases. Concrete work shall be in conformance with Division 03 Specifications.

B. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

C. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

D. Furnish excavating and backfilling to install work specified in the Mechanical Division. Refer to Mechanical Drawings and Division 31 Section “Earthwork” for methods and materials.

E. Provide all pumping and well pointing required to keep mechanical excavations dry.

3.11 ACCESSIBILITY AND ACCESS PANELS

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.

B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Access doors shall be furnished for accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Architect/Engineer.

C. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Architect/Engineer.

D. Furnish access doors as required to make accessible all valves, controls, coils, motors, air vents, filters, motorized dampers, electrical boxes and other equipment installed by Mechanical trades or as required by Code. Refer to Division 08 for the type of access doors required. Refer to drawings and specifications for the type of access door to be provided at the outside air intake duct.

E. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.

F. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect/Engineer for review before access doors are purchased or installed.

G. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

3.12 FIELD QUALITY CONTROL, STARTING, ADJUSTING AND COMMISSIONING

A. Tests and Inspection: When the systems are completed, operate equipment as directed by Architect/Engineer. Replace all faulty equipment. Make necessary adjustments before final acceptance.

1. Perform all tests required by State, City, County and/or other agencies having jurisdiction.
2. Provide all materials, equipment, etc., and labor required for tests.

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

F. Perform the commissioning activities as outlined in the Division 01 Section “Commissioning” and other requirements of the Contract Documents.

G. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a weekly basis.
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the CxA.
6. Complete paper or electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.

H. Refer to related information in other sections for additional requirements.

I. Maintenance Materials: Retain all portable and detachable portions of the installation such as keys, tools, manuals, etc., until the completion of the work and then them over to the Owner and obtain itemized receipt. This receipt shall be attached to the "Final Application" for payment.

3.13 TRAINING AND INSTRUCTION PROGRAM

A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.

1. Basis of System Design and Operational Requirements
2. Documentation
3. Emergencies
4. Adjustments
5. Troubleshooting
6. Maintenance
7. Repairs

C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

D. Video Record: Training shall be recorded as digital video.

3.14 CLEANING AND WASTE MANAGEMENT

A. Keep premises free from accumulation of waste materials and rubbish. At completion of work remove all rubbish from and about the building and leave the mechanical systems clean and ready for use.

B. Close and tightly seal all partly used containers and store protected in well-ventilated, fire-safe area at moderate temperature. Deliver to reuse and/or recycle facilities if not removed from site for Contractor’s reuse.

C. Separate and recycle waste materials in accordance with the Waste Management Plan and to the maximum extent possible.

D. Separate metal waste, packaging, and all other materials in accordance with the Waste Management Plan and place in designated areas for recycling or reuse.

E. Check with manufacturer for recycling options. Most manufacturers take back scrap and unused portions for resale or manufacturing into new product.

END OF SECTION 20 0500

SECTION 20 0513 – COMMON MOTOR REQUIREMENTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and three-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors and single-phase, fan/pump-duty, horizontal, small and medium, electronically commutated, permanent magnet (EC) motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.4 SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

1. Each installed unit's type and details.
2. Complete NEMA nameplate electrical data including design type, insulation, service factor, and efficiency
3. Diagrams of power and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.
4. Bearing type, L10 life, and seal construction (open, single, or double shielded).
5. Certification that electronic VFD driven motors comply with NEMA MG-1 Part 31.
6. Ground ring and ceramic bearing details as applicable

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around field-installed motors. Show motor layout, mechanical power transfer link, driven load, and relationship between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Test Reports: Written reports from testing procedures outlined in Part 3.

E. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise:

1. NFPA 70: National Electrical Code.
2. NEMA Standards Publication MG 1 (2011): Motors and Generators.
3. ABMA 9: American Bearings Manufacturers Association, Load Ratings and Fatigue Life for Ball Bearings
4. UL 1004: Motors, Electric

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.

D. Product Options for Field-Installed Motors: Drawings indicate size, profiles, and dimensional requirements of motors and are based on the specific system indicated.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Motor controllers
b. Magnetic controllers
c. Multispeed controllers
d. Reduced-voltage controllers

2. Designed and labeled for use with variable frequency drives as applicable, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.
5. Ambient and environmental conditions of installation location

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products of the following manufacturers:

1. Reliance Electric
2. Baldor Electric Company
3. General Electric
4. U. S. Electric Motors

5. Marathon Electric
6. Toshiba Corp

2.2 MOTOR GENERAL REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor requirements apply to factory-installed and field-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
3. Motor Connections: Multiple power connections not allowed.

C. Motors Less Than 1/2 HP: Single-phase

D. Motors 1/2 HP and Larger: Three-phase.

E. Frequency Rating: 60 Hz, alternating current.

F. Voltage rating of motor shall be determined by voltage of circuit to which motor is connected:

1. 120 V Circuit: 115 V motor rating.
2. 208 V Circuit: 200 V motor rating.
3. 240 V Circuit: 230 V motor rating.
4. 480 V Circuit: 460 V motor rating.

G. Service Factor: 1.15 for open drip-proof motors; 1.0 for totally enclosed motors and inverter duty motors.

H. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3,300 feet above sea level.

I. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

J. Motors shall be NEMA Design B.

K. Provide Class B insulation, unless noted otherwise.

L. All disconnects and other electrical accessories shall comply with Division 26 requirements

M. Motors shall be nominal 1,800 rpm, unless noted otherwise.

2.3 SINGLE-PHASE MOTORS

A. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

B. Use shaded pole motors only for motors smaller than 1/20 HP.

C. Provide automatic reset type thermal over-load protection.

D. Bearings: Sealed or regreasable ball or sleeve bearings, suitable for the radial and thrust loading of the application.

E. Furnish with sliding base/slotted mounting holes adequate for proper belt tensioning and alignment of motor or motor/load.

F. Nameplates may be printed-type glued to the motor.

2.4 SINGLE-PHASE EC MOTORS

A. Motors equal to or smaller than 1 HP shall be Electronically Commutated (EC) type, to suit starting torque and requirements of specific motor applications.

B. Bearings: Pre-lubricated, antifriction ball bearings suitable for radial and thrust loading.

C. Motors: Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20 percent of full speed (80 percent turndown). Motor shall be a minimum of 85 percent efficient at all speeds.

1. Variable speed, 0 - 2,000 RPM.
2. Adjustable delay profile.
3. 0 - 10 volt input signal.
4. Output signal.
5. Programmable ramp rate.
6. Soft start.
7. Remote controller.
8. Moisture resistant.
9. Insulation: Class H.
10. Enclosure: Class 2, IP44.
11. Integrated motor protection (electronically protected).
12. UL 778, 1004-1, 508C.
13. CAN/CSA C22.2 #108, #100, #107.1.
14. EMC (89/366 EEC): EN 61000.
15. LVD (73/23/EC): EN 60335-1, EN 60335-2-51.
16. Machine Safety (98/37/EC): EN ISO 12100.

2.5 THREE-PHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor

B. Enclosure: Open Drip Proof (ODP) unless noted otherwise in equipment specifications or schedules, and as suitable for service and application.

C. Motor Efficiency: Nominal (nameplate) full load efficiency and corresponding minimum efficiency shall be equal to or greater than that stated in NEMA MG-1 (2011) Table 12-12 – Full Load Efficiencies of 60hz NEMA Premium Efficient Electric Motors - 600 volts or Less.

1. “Premium Efficient” for all motors 1 hp and larger, including those furnished as part of equipment specified in equipment sections. The Contractor shall confirm utility company minimum requirements for incentive programs and provide motors with efficiencies that meet or exceed the most stringent between NEMA MG-1 and utility company incentive program requirements. The Contractor, at no extra charge to the Owner, shall replace any motor that does not meet the utility company’s incentive program. The efficiency and/or “NEMA Premium Efficiency” shall be displayed on the motor nameplate and clearly indicated on the equipment shop drawings submitted for approval.

D. Motors less than 3 HP**:** Steel or cast iron motor frames, cast aluminum, cast iron, or steel end plates, steel or cast iron terminal box, copper windings. Motor nameplates shall be steel, engraved-type, riveted to motor.

1. Bearings: Regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings, selected for a minimum L-10 bearing life of 26,280 hours, for belted and direct drive.

E. Motors 3 HP and above: cast iron motor frame and mounting feet, cast iron end plates (bells), steel or cast iron terminal box, copper windings. Motor nameplates shall be stainless steel engraved type, riveted to the motor.

1. Bearings shall be regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings. Rated for an L-10 life of 40,000 hours (belted) or 130,000 hours (direct connected).

F. Bearing life calculations shall be per ABMA 9, and for belted applications shall be based on the maximum external side load limits for belted applications per NEMA MG-1 Table 14-1A. L-10 life calculations for vertical motors and horizontal motors mounted in the vertical position shall consider the application's thrust loading.

G. TEFC motors shall also include an external shaft slinger on drive end.

H. Multispeed Motors: Variable torque.

1. Separate windings shall be provided for each speed

I. Stator: Copper windings.

J. Rotor: Random-wound, squirrel cage.

K. Temperature Rise: Match insulation rating.

L. Insulation: Class F.

M. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

N. Motors shall not exceed dBA levels listed in NEMA MG-1 54 PART 9 Tables 9-1 and 9-3, at all speeds.

O. Motors shall be suitable for continuous duty at rated horsepower, with a maximum hot spot temperature that does not exceed the temperature limit of the insulation, when operated in an ambient temperature of 40 degrees C, except as otherwise indicated.

P. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable NEMA foundation sliding bases.

Q. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

R. For motors used with variable frequency drives, provide General Purpose NEMA Premium Efficiency Class motors complying with NEMA MG-1 Part 30 with windings that meet the requirements of NEMA MG-1 Part 31.4.4.2 and with minimum insulation of Class F.

1. For all PWM VFD driven motors up to 100 HP: Provide a maintenance free, circumferential conductive micro fiber grounding ring installed on the AC motor to discharge shaft currents to ground. Grounding ring shall be AEGIS SGR (Shaft Grounding Ring).
2. Motors protected by the AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced bearing current damage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.

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

3.2 MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Comply with mounting and anchoring requirements specified in Section 20 0548 "Vibration Controls for Mechanical."

3.3 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
2. Test interlocks and control features for proper operation.
3. Verify that current in each phase is within nameplate rating.

B. Testing: Owner shall engage a qualified testing agency to perform the following field quality-control testing should the proper performance of the motor be in question. If motor performance is found to be deficient, Contractor shall replace motor at no cost to Owner.

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.4 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

B. Verify that bearings are factory lubricated before starting motors. Lubricate per manufacturer’s instructions. Do not over-lubricate bearings.

C. Check motors for unusual heating, noise, or excess vibration during operation. Correct any such deficiencies.

1. Any motors with vibration exceeding specified limits, as noted in the Testing, Adjusting and Balancing Section, or manufacturer's recommendations, whichever is more stringent, shall be corrected, at no cost to Owner, until reduced below those limits.

3.5 MOTOR CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

3.6 MOTORS USED WITH VARIABLE FREQUENCY DRIVES

A. Install shaft grounding rings on all equipment motors using variable speed drives.

B. Install per manufacturer's instructions.

C. Assure grounding of SGR to motor frame.

END OF SECTION 20 0513

SECTION 20 0519 – THERMOMETERS, PRESSURE GAUGES, METERS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

A. Thermometers, pressure gauges, meters and accessories.

1.3 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
2. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.
3. ASME/ANSI B40.1, Pressure Gauge Standard.
4. National Sanitation Foundation NSF/ANSI-61 (potable drinking water) and NSF-61 Annex G (listed as ≤ 0.25% weighted average lead content) Applies to any item in contact with domestic water.
5. US Safe Drinking Water Act.

1.4 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.

C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

PART 2 - PRODUCTS

2.1 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

Service	Range (Degrees F)
Domestic Cold Water	0-120
Domestic Hot Water	0-180
Heating Hot Water	0-200

B. Range and Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

C. Thermometer Wells: Brass or stainless steel, with neck extension for insulated piping, with cap and chain fastened to well. 3/4"NPT, 2 1/2" insertion length, and extension length as required to extend well to outside of insulation. Lead free when used for domestic water applications.

D. Outdoor thermometers shall be ultraviolet proof and specifically manufactured for outdoor use.

2.2 GLASS THERMOMETERS

A. Manufacturers:

1. Industrial Glass
2. H.O. Trerice
3. Weksler
4. Marsh
5. Ashcroft
6. Weiss
7. Miljoco Corporation

B. Industrial Glass Thermometer: adjustable angle, scale to be 9" long with white aluminum back and black graduation, aluminum casing, blue appearing liquid tube, glass window. Stem for air duct shall be 6" long with protective aluminum slotted bulb guard and mounting flange. Stem for piping shall be 3-1/2" long aluminum, brass or stainless steel, stem to match specified thermometer well. Adjust stem length for insulation extension.

2.3 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer
2. H. O. Trerice
3. Weksler
4. Marsh
5. Ashcroft
6. Weiss
7. Miljoco Corporation

B. Unless otherwise noted, provide all pressure gauges with clear glass window, cast aluminum, stainless steel or polypropylene case, black on white face, stainless steel wetted parts, brass 1/2" MPT socket, 1% full scale accuracy complying with ASME/ANSI B40-1 Grade 1A. Lead free when used for domestic water applications.

C. Water and Compressed Air Services through 2" piping: 2 1/2" diameter face, stainless steel case, brass or stainless steel 1/4" MPT socket, 2% full scale accuracy.

D. Water and Compressed Air Services over 2" piping: 4 1/2" diameter face, 6" diameter face for location more than 8 feet above floor, sealed glass window, glycerin filled for connections within 10 feet of pumps. For applications exceeding 145 deg. F, provide 316 stainless steel needle valves rated minimum 500 psi, in lieu of glycerin filled.

E. Except where noted otherwise, select range for twice normal operating pressure:

1. Water (CW and HW): 0-100 psig
2. Compressed Air: 0-125 psig

F. Outdoor gauges shall be ultraviolet proof and specifically manufactured for outdoor use.

2.4 PRESSURE-GAUGE FITTINGS

A. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

B. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.5 PRESSURE/TEMPERATURE TEST PLUGS AND KITS

A. Manufacturers:

1. Plugs:

a. Peterson Products Company (Pete's Plug)
b. Schrader
c. Sisco
d. Miljoco Corporation

2. Meter:

a. Auto Flow
b. Griswold

B. Provide 1/4" brass pressure and temperature test plugs where shown on drawings, with two core Nordel rated for 275 degrees and 300 psig.

C. Provide one readout meter kit including required hoses with a minimum 3-1/2" dial differential pressure gauge. Gauge shall read 0 to 60 psig and have end connections to match both the flow valves and plugs. Included in the case shall be two pocket thermometers (25 to 125 and 0 to 220 degrees), gauge adapter, and one pocket pressure gauge (0 to 160 psig). Meter shall become property of Owner (hand over to Owner's Project Manager) after completion of work.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION – GENERAL

A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 INSTALLATION OF THERMOMETERS

A. Install and orient wells and thermometers so thermometer can be read from the floor.

B. Thermometer Wells: For piping 2" and below, install in piping tee where thermometers are indicated, in vertical position. For piping 2 1/2" and above, "weldolets" may be used. Fill well with oil or graphite and secure cap.

C. Install as indicated on the drawings

3.3 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges with 1/2" isolation ball valve. Where needle valves are specified as a substitute for glycerin filled in Part 2, install the needle valve between the ball valve and the gauge. Locate gauges to be readable from the floor preferably at eye level. Mount gauges securely to prevent excessive vibration, adjust needle valve to dampen pulsations. Install syphon tubes for steam pressure gauges, connected after the isolation ball valve. Do not install pressure gauges on bottom of piping.

B. Install as indicated on the drawings

3.4 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.5 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 20 0519

SECTION 20 0523 – VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide valves as scheduled and specified in this Section for the following systems:

1. Domestic Cold Water, Hot Water, Hot Water Return
2. Natural Gas
3. Heating Hot Water and Non-Potable Water
4. Refrigerant
5. Compressed Air / Lab Vacuum
6. Other similar piping systems except where specialty valves are specified under other sections

1.3 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. National Sanitation Foundation NSF/ANSI-61, including Annex G (listed as ≤ 0.25% weighted average lead content) (and/or NSF/ANSI-372) and Annex F. Applies to any item in contact with domestic (potable) water.
2. US Safe Drinking Water Act (any item in contact with domestic (potable) water).

1.4 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.5 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL VALVE REQUIREMENTS

A. All valves shall have bodies, seats, stem seals and disc materials compatible with intended fluid, temperature, pressure and service.

B. Valve Pressure and Temperature Ratings: Unless noted otherwise, valves shall be rated for a minimum of 125# WSP (working steam pressure)/ 250# WOG (cold water, oil, gas).

C. Unless noted otherwise, valves through 2" shall have screwed connections for steel piping and sweat connections for copper piping. Domestic cold water, hot water and hot water return shall have sweat connections (lead free); valves 2-1/2" and larger shall be flanged.

D. Valves in contact with domestic (potable) water shall be “lead free” NSF/ANSI-61 Annex G (and/or NSF/ANSI-372) labeled.

E. All EPDM shall be peroxide cured. All wetted seals shall be made from materials that are immune from chloramine degradation.

F. Manually operated valves 4" and larger installed 10 feet above finished floor or higher, shall have chain wheel operators. Chain shall reach to within 7'-0" of floor or operating platform, or within two feet of accessible ceiling.

G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

H. Provide extended valve stems for insulated piping.

I. Where the valves are installed outdoors, all components including the gear operated wheel operators shall be weatherproofed.

J. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

K. Valve Bypass and Drain Connections: MSS SP-45.

L. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840 deg F for angle, check, and globe valves; below 421 deg F for ball valves.

M. Threaded: With threads according to ASME B1.20.1.

2.2 BALL VALVE

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

1. Apollo
2. Milwaukee
3. NIBCO
4. Watts
5. Bonomi
6. Jomar

B. Two-piece, full port, bronze body, stainless steel ball and stem:

1. Description:

a. Standard: MSS SP-110
b. SWP Rating: 150 psig
c. CWP Rating: 600 psig
d. Body Design: Two Piece
e. Body Material: Bronze
f. Ends: Threaded
g. Seats: PTFE or TFE
h. Stem: Stainless Steel
i. Ball: Stainless Steel, vented
j. Port: Full
k. Handle: Plastic Coated Lever
l. Locking Device: When Noted on Drawings
m. Approvals: UL or CSA for Natural Gas Service

2.3 BUTTERFLY VALVE

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

1. Bray
2. Dezurik
3. Jamesbury
4. Milwaukee
5. Tri-Seal Valve
6. Xomox
7. ABZ 397 Series
8. Jomar

B. Unless noted otherwise, all butterfly valves shall be full lug construction, suitable for bi-directional dead end service, and have open position memory stop. Manually operated butterfly valves 4" and larger shall have enclosed worm gear operators with position indicators.

C. Class 150 Butterfly Valves:

1. Description:

a. Resilient Seat
b. Standard: MSS SP-68
c. CWP Rating: 200 psig at 150 Deg F
d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
e. Body Material: Ductile Iron
f. Seat: EPDM
g. Shaft: Positive Drive Blow-Out Proof 416SS Shaft, graphite Teflon impregnated stem bushings, O-ring stem seal
h. Disc: 316 Stainless Steel
i. Service: Bidirectional

2.4 HIGH PERFORMANCE BUTTERFLY VALVE

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

1. Bray – Braylok Series 41
2. Dezurik – BHP
3. Jamesbury - 815L
4. Milwaukee - HP Series
5. Tri-Seal Valve-Contromatics
6. Xomox Pliaseal
7. ABZ Absolute Series 402

B. Unless noted otherwise, all butterfly valves shall be full lug construction, suitable for bi-directional dead end service, and have open position memory stop. Manually operated butterfly valves 4" and larger shall have enclosed worm gear operators with position indicators.

C. Class 150 High-Performance Butterfly Valves:

1. Description:

a. Standard: MSS SP-68
b. CWP Rating: 150 psig at 250 Deg F
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel (316 SS if required for NSF 61 compliance for domestic water)
e. Seat: Reinforced PTFE
f. Shaft: 17-4 PH Stainless Steel; offset from seat plane with Teflon stem packing
g. Disc: 316 Stainless Steel
h. Bearings: 316SS/PTFE Upper and Lower Stem
i. Seat Leakage: ANSI Class VI
j. Service: Bidirectional

2.5 SWING CHECK VALVE

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

1. Milwaukee 509
2. Crane 37
3. Grinnell 3300
4. NIBCO
5. Apollo
6. Kitz

B. Bronze body and trim swing check valve

2.6 SILENT CHECK VALVE

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

1. Wafer Style:

a. Milwaukee - Series 1400
b. APCO - Series 300
c. Mueller
d. Metraflex
e. Titan Flow Control, Inc.

2. Globe Style:

a. Milwaukee
b. APCO
c. Mueller
d. Metraflex
e. Apollo
f. Titan Flow Control, Inc.

B. Spring loaded type check valve, stainless steel spring, iron body and bronze trim

2.7 LUBRICATED PLUG VALVE

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

1. Homestead
2. Miliken
3. Resun

B. Class 125, Lubricated Plug Valves:

1. Description:

a. Standard: MSS SP-78
b. NPS 2” and Smaller: CWP Rating: 150 psig, bronze body, square head, threaded ends
c. NPS 2-1/2” and Larger: CWP Rating: 175 psig, semi-steel body, wrench operated, single gland, flanged ends
d. Pattern: Straight away
e. Plug: Cast iron or bronze with sealant groove

2.8 DRAIN VALVE

A. General Service: Ball valve with 3/4-inch hose threaded end fitting and cap.

2.9 MANUAL BALANCING VALVE

A. General Manual Balancing Valve Requirements:

1. Provide ports for measuring flow, memory stop, bubble tight shut-off, valve Cv characteristics suitable for throttling.
2. Size valve to produce readable design flow and maximum full open pressure drop of 3 feet.
3. Ensure NSF 61 compliance for balance valves used in domestic (potable) water systems

B. Through 2": brass body, brass or stainless steel ball or brass disc or plug, calibrated.

1. Manufacturers:

a. Bell & Gossett Circuit Setter Plus
b. Armstrong
c. IMI Flow Design Accusetter
d. Taco
e. Victaulic

C. Valves 2-1/2"and larger: cast iron or ductile iron body, brass ball or brass or bronze disc, EPDM seat, and brass or stainless steel stem.

1. Manufacturers:

a. Bell & Gossett Circuit Setter Plus
b. Armstrong
c. IMI Flow Design Accusetter
d. Taco
e. Victaulic

D. Venturi Style: bronze body, brass ball, and venturi flow measuring station.

1. Manufacturers:

a. Preso B Plus
b. IMI Flow Design Accusetter

E. Provide gauge kit for projects requiring over 20 balancing valves. Gauge kits shall be capable of directly reading GPM or shall include conversion chart from Cv and pressure. Provide to Owner's Project Manager

2.10 SOLENOID VALVE

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

1. Magnetrol Figure No. 200-A
2. ASCO
3. Skinner

B. Full port, bronze body, malleable iron coil enclosure, stainless steel plunger, valve stem, bonnet tube, and spring, Buna-N seal, rated for 500 psi. See drawings for voltage, size and position (NC or NO).

2.11 REFRIGERANT VALVES & SPECIALTIES

A. General: Complete valve assembly shall be and designed to conform to ARI 760.

B. Globe: 450 psig maximum operating pressure, 275 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.

C. Check Valves:

1. Smaller Than 7/8 Inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections

2. 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

D. Solenoid Valves: UL-listed, 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, holding coil, voltage to meet controls requirements.

E. Thermal Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line, and an external equalizer line.

F. Hot Gas Bypass Valve: adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading; and wrought copper fittings for solder end connections.

G. VRF refrigerant isolation valves: Compatible with R410A and PVE (polyvinyl ether oil), operating range of -40F to 300F, working pressure of 550 psi (capable of transient pressure spikes to 700 psi), full port valve with zero pressure drop, bi-directional flow, service port in valve body, brazed connections.

H. Charging and Purging Valves:

1. Manufacturer: Henry

I. Refrigeration Ball Valve:

1. Manufacturer: Henry

J. Refrigeration Piping Specialties

1. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.
2. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.
3. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 deg. F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.
4. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:

    a. Standard capacity desiccant sieves to provide micronic filtration.
    b. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

5. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.
6. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets, as follows:

    a. Standard capacity desiccant sieves to provide micronic filtration.
    b. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

7. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length. Manufacturer: Anaconda

PART 3 - EXECUTION

3.1 VALVE APPLICATION SCHEDULE

A. Domestic Cold Water/Hot Water/Hot Water Return Systems:

1. Isolation through 2": Ball Valve
2. Isolation 2-1/2" and Larger: Butterfly Valve NSF 61 Compliant
3. Main Service Water Valve at Building Entrance: High Performance Butterfly Valve NSF 61 Compliant
4. Check 2-1/2” and Larger: Silent Check Valve
5. Balancing: Manual Balancing Valve

B. Natural Gas System:

1. Isolation through 2”: Ball Valve certified by UL or CSA for natural gas.
2. Isolation 2 1/2" and Larger: Lubricated Plug Valve

C. Heating Hot Water/Non-Potable Water Systems:

1. Isolation through 2": Ball Valve.
2. Isolation 2-1/2" and Larger: Butterfly Valve.
3. Check through 2”: Swing Check Valve
4. Check 2-1/2” and Larger: Silent Check Valve
5. Balancing: Manual Balancing Valve

D. Compressed Air/Lab Vacuum Systems:

1. Isolation through 2": Ball Valve
2. Isolation 2-1/2" and Larger: Butterfly Valve
3. Check through 2”: Swing Check Valve
4. Check 2-1/2” and Larger: Silent Check Valve

E. Valves for Mechanical Press Fit Piping Systems:

1. The mechanical press fit system manufacturer’s standard isolation ball valves through 2” shall be allowed provided they meet the ball valve specification in Section 2 above.

3.2 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20, 21, 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves such that operator is completely operable, and the valve position indicator is discernible from the floor.

C. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Provide branch isolation valves at all branch piping take-offs from main headers whether specifically indicated on the drawings or not. This pertains to all piping systems.

F. Install valves in horizontal piping with stem at or above center of pipe.

G. Install valves in position to allow full stem movement.

H. Solenoid Valve Installation Requirements:

1. Provide a strainer before each solenoid valve. Provide a water hammer arrestor upstream of solenoid valves used for water service.

I. Natural Gas Valve Installation Requirements:

1. Install valves in accessible locations, protected from physical damage. Do not locate valves in plenum ceilings.
2. Install isolation valve upstream and within 6 feet of gas appliance. Install a union or flanged connection downstream from the valve to permit removal of controls.

J. Domestic Hot Water Valve Installation:

1. For general service applications: steam and condensate flanged valves shall be installed with Flexitallic gaskets, 316L stainless steel, with “Flexicarb” filler.
2. For general service applications, domestic hot water flanged valves shall be installed with 100% PTFE gaskets, Interlex SQ-S.

END OF SECTION 20 0523

SECTION 20 0529 – HANGERS AND SUPPORTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping ductwork and equipment.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and equipment support by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design and extent.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.6 SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

C. Shop Drawings – Non-Penetrating Rooftop Hangers and Supports:

1. Provide project specific, engineered stamped shop drawings and calculations including extents of installation, load bearing capacity and structural requirements.
2. Show installation layout, indicating product type and spacing. Coordinate with manufacturer's take off evaluations, measurements, control dimensions, and rooftop requirements analysis.
3. Show details of each roofing system including material layers and thicknesses, flashing, terminations, and penetrations with each rooftop support system to be installed.
4. All supports shall be pre-assembled and shipped for turnkey installation. Indicate all steps and preparation required by others.

1.7 DELIVERY, STORAGE AND HANDLING

A. Package for delivery to best protect finish surfaces while using the least amount of single-use packaging as possible. If possible, package and ship product using reusable blankets and fabrics or reusable cardboard and crate systems.

B. Protect materials against weather and contact with damp or wet surfaces from time of delivery through time of installation. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes.

C. When storing prior to installation, raise off floor on pallets, stack flat with protective material between to eliminate chance of creating nicks, scratches, and other imperfections and damage to finish surfaces, wrap weather-tight, and provide for air circulation within and around stacks and under temporary coverings.

D. Do not allow materials to become damp. Maintain temperatures at 60°F or higher, and humidity between 20% and 60% prior to, during and after installation.

1.8 WARRANTY

A. Non-Penetrating Rooftop Hangers and Supports:

1. Provide manufacturers standard product warranty against defects in manufacturing, proper operation, and against damaging roofing membrane when products are installed in accordance with engineered shop drawings and manufacturer's instructions. Warranty is not a maintenance agreement, insurance policy or obligation to repair leaks determined to be a result of the building design, installation, construction error, misuse of system, failure to inspect or maintain system or other limitations in manufacturer's standard warranty.

    a. Warranty Period: 20 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pipe Hangers:

    a. Anvil
    b. Cooper B-Line
    c. Carpenter & Patterson, Inc.
    d. PHD Manufacturing
    e. Unistrut Corporation
    f. Powerstrut

2. Channel Support Systems:

   a. Anvil
   b. Cooper B-Line
   c. Carpenter & Patterson, Inc.
   d. PHD Manufacturing
   e. Unistrut Corporation
   f. Powerstrut

3. Thermal-Hanger Shield Inserts:

   a. Cooper B-Line
   b. ERICO International Corporation
   c. Pipe Shields, Inc.
   d. Rilco Manufacturing Company
   e. Value Engineered Products
   f. American Mechanical Insulation Sales

4. Non-Penetrating Rooftop Hangers and Supports:

   a. nVent Caddy Pyramid
   b. Miro Industries, Inc.
   c. Big Foot Systems

5. Cast in Place Concrete Inserts:

   a. Unistrut
   b. Grinnell
   c. Anvil Fig 285 for loads up to 400 lb
   d. Anvil Fig 281 for loads up to 1200 lb

6. Powder-Actuated Fastener Systems: **NOT ALLOWED**

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Provide adjustable type pipe hangers, supports and accessories for the proper support of all piping.

B. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Application" Article in Part 3 for where to use specific hanger and support types.

C. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

D. Copper Pipe Hangers:

1. Description: MSS SP-58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper coated steel.

E. Dielectric protection for hangers and supports: Where copper piping is supported with steel hangers and supports, dielectric protection must be provided. Use one of the following means as applicable:

1. Coated hangers (copper or plastic coating)
2. Insulation inserts
3. Cushion clamps

2.3 METAL FRAMING/CHANNEL SUPPORT SYSTEMS

A. Metal Framing Manufacturer's Association (MFMA) Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with in-turned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel for general applications.
6. Metallic Coating: Manufacturer's standard finish, unless bare metal surfaces are indicated.
7. Paint Coating: None
8. Plastic Coating: Provide on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
9. Combination Coating: None

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 THERMAL-HANGER SHIELD INSERT ASSEMBLIES

A. Except as noted, thermal hanger shield "insert" assemblies shall be used on all insulated pipe systems at each horizontal support, and at each clamped or guided vertical support. Manufactured units shall comply with MSS SP-58 standards and be tested per MSS SP-89 guidelines. Each assembly shall closely fit the various pipe diameters and match the outside diameter of the adjoining pipe insulation. Provide pre-grooved inserts when piping is heat traced. Compressive strength shall be adequate to prevent deformation at the project's hanger spacing requirements, with a minimum 3:1 safety factor.

B. Thermal hanger shield insert assembly: Water-repellent treated, ASTM C 533, Type I calcium silicate, asbestos free insert. With G-90 galvanized sheet metal shield. With attached vapor barrier, where indicated. Each component shall have an ASTM E84 flame/smoke rating maximum of 25/50.

C. Inserts for Cold Piping (piping conveying materials less than or equal to 60F), including all chilled water and domestic cold water piping: Insert with an attached vapor barrier.

1. Provide insert and sheet metal shield covering entire circumference of pipe.

D. Inserts for Hot Piping (piping conveying materials at more than 60F and that is required to be insulated): Insert only with no vapor barrier.

1. For clevis or band hangers that support pipe from bottom: Insert and sheet metal shield shall cover lower 180 degrees of pipe, or entire circumference of pipe.
2. For trapeze hangers or clamped pipe: Insert and sheet metal shield shall cover entire circumference of pipe.

E. Inserts for piping less than 3/4 inch diameter: Not required except for piping conveying materials less than 45ºF.

F. Minimum Compressive Strength of Insert Material:

1. 100 psig for sizes smaller than NPS 6.
2. 600 psig for sizes NPS 6 and larger.

G. Insert Length: Extend 2 inches beyond sheet metal shield.

H. Vapor barrier: meeting ASTM C1136, with 0.02 perms maximum water vapor permeance.

I. Adhesives shall comply with NFPA 90-A.

J. Sheet Metal Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
2. NPS 4: 12 inches long and 0.06 inch thick.
3. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick
4. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick

2.6 BUILDING ATTACHMENTS FOR MECHANICAL WORK SUPPORTS

A. General Requirements:

1. Provide building attachments required for supporting mechanical work, suitably selected and installed for the loads applied with a minimum additional safety factor of 3.
2. Where specified attachments are not suitable for conditions, submit to Engineer for approval, proposal for alternate building attachments.
3. Provide supplemental trapeze supports where necessary. Design trapeze to support all trades. Coordinate loads and supports with all trades. Size trapeze for maximum deflection of 1/64 of the span.

B. Attachments to Structural Steel:

1. Support mechanical work from building structural steel where possible and approved. No welding or bolting to structural steel is permitted unless authorized by Architect. C-clamps are only allowed when restraining straps are used. C-clamps can be used without restraining straps for Division 21 work only.

C. Drilled Insert Anchors:

1. Where mechanical work cannot be supported from structural steel, or cast in place concrete inserts, provide drilled concrete insert anchors. Submit for approval, project specific installation drawings for all loads over 100 lbs. Install inserts in web of beam if possible and approved. Insert depth shall not exceed two thirds the thickness of the concrete. Where existing concrete appears to be deteriorating, or where applied load at insert exceeds 1000 lbs., conduct test of concrete to determine de-rated capacity of insert. Anchors may be adhesive or expansion type up to 1000 lbs., and shall be adhesive type for loads over 1000 lbs.

D. Attachments to metal decking: **NOT ALLOWED**.

2.7 ROOFTOP HANGERS AND SUPPORTS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Non-Penetrating Rooftop Hangers and Supports:

1. Dynamic Support Piping up to 3": Roller bearing pipe support for roof-mounted gas pipes with the following properties:

a. Base Material: Polycarbonate.
b. Deck Base: 9 by 15-1/4 inch.
c. Pipe Clearance: Adjustable from 4-1/2 inch to 13 inch.
d. Maximum Load Weight: 186 pounds per pipestand.
e. Pipe Rests: Self-lubricating polycarbonate resin roller, axle, and collar.
f. Support All-Thread and Metal Parts: Stainless Steel.
g. Nominal Inside Diameter: 3 inch.
h. Maximum Outside Diameter: 4-1/2 inch.
i. Spacing: Horizontal support spacing per pipe specification. Manufacturer's suggested spacing shall not exceed 10 foot centers as loading permits.

2. Custom Duct Supports: Duct support is a custom product designed for single or multiple duct supports. Provide rooftop duct layout shop drawings for manufacturer's use and the following:

a. Deck Bases: Polycarbonate, 16 by 18 inch.
b. Duct Dimensions: Refer to drawings.
c. Minimum/Maximum Clearance Above Roof: 12/18 inches.
d. Duct Insulation Thickness: Refer to Section 20 0700 "Mechanical Insulation".
e. Maximum Outside Dimension: Refer to drawings.
f. Total Length of Duct Run: Refer to drawings.
g. Quantity of Supports Required: To be determined by duct support manufacturer.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Non-staining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

D. Support Pads: Designed specifically to fit non-penetrating rooftop supports while protecting the rooftop envelope. Slip resistant and heat molded with a small lip to hold the support pad and reduce movement on the rooftop.

1. Support Pad Material: 100 percent recycled rubber.
2. Dimensions: Minimum 2 inches larger than support base width and length.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Comply with MSS SP-69 for pipe hanger selections and applications

B. Comply with all guidelines and limitations for loading and fastening where indicated on structural or architectural project documents.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel for pipe hangers, supports and attachments for general service applications.

F. Use corrosion resistant steel for pipe hangers, supports and attachments for outdoor use and for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 20 with steel pipe base stanchion support and cast-iron floor flange or carbon steel plate.
3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
4. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

K. Vertical Piping Clamps: Unless otherwise indicated, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 24, if longer ends are required for riser clamps.

L. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Support mechanical work from building structural steel where possible and approved. No welding or bolting to structural steel is permitted unless authorized by Architect.
3. C-clamps are allowed with restraining straps only.
4. Center-Beam Clamps (MSS Type 21 or 28) for loads over 120 lb: For attaching to center of bottom flange of beams. Malleable center hung Anvil Fig. 228.
5. Side-Beam Clamps (MSS Type 20 or 27) - for loads up to 120 lb

N. Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length and thickness per Section 2.5 above.

O. Thermal-Hanger Shield Inserts: Used on all insulated pipe systems at each horizontal support, and at each clamped or guided vertical support per Section 2.5 above.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Framing/Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer's written instructions.

C. Metal Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, trapeze pipe hangers

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Non-Penetrating Rooftop Hangers and Supports: Install in accordance with manufacturer’s instructions.

1. Clean roofing surfaces in accordance with the roofing manufacturer's instructions prior to installation.
2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for each substrate under the project conditions
3. Install supports and hangers in accordance with manufacturer's recommendations.
4. Install supports at maximum spacing of 10 feet unless closer spacing is required due to weight of pipe or conduit requirements, or greater spacing is specifically allowed by support manufacturer.

    a. Space and adjust supports to evenly distribute weight.
    b. Do not exceed support manufacturer's recommended load limits or specified mechanical piping limits.

5. Remove roofing aggregate from area 2 inches larger than support base; comply with roofing manufacturer's requirements to maintain roofing warranty.
6. Install support pad beneath each support base.
7. Support Pads:

    a. Remove rock, aggregate, dirt and excess dust from area to be covered by pad.
    b. Apply support pad on cleaned area.
    c. Center bases on top of support pads.

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

K. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 or Smaller: Maximum span, 5 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.

L. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 or Smaller: Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
7. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
9. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4 inch.

M. Install hangers for cast iron drainage piping minimum of one (1) hanger per pipe section close to joint on the barrel, at change of direction and at branch connections. Hanger and rod diameters for each pipe size shall be as indicated below.

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

N. Support cast-iron piping vertical runs at roof, at each floor, and at 10-foot intervals between floors.

O. Support vertical runs at roof, at each floor, and at 48 inches intervals between floors.

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," are not exceeded.

Q. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping not required with vapor retarder insulation: Clamp may project through insulation.
b. Piping required with vapor retarder insulation: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits according to ASME B31.9.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 20 0529

SECTION 20 0548 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide vibration control items for isolating vibration of mechanical equipment, piping and ductwork.

B. Provide isolators, bases, pads, sleeves, hangers and other devices specified, required, or detailed for the project. Include all vibration isolation system elements as recommended by the equipment manufacturer's representative to ensure a complete, high performing and safe installation. Furnish and install all incidental materials required.

C. Items included in this section:

1. Flexible duct connectors
2. Flexible pipe connectors
3. Flexible metal hose
4. Vibration isolators

1.3 QUALITY ASSURANCE

A. Work of this section shall be performed by suppliers and skilled tradesmen who are experienced in vibration control and mitigation to meet the requirements of this Section.

B. Provide field supervision and inspection to ensure proper installation, adjustment and performance. Replace any isolators that are found to resonate with the supported equipment.

C. Isolators shall be selected, installed and adjusted to prevent the transmission of objectionable vibration and noise to the building structure.

D. The size and number of mounts and hangers shall be chosen to meet these specifications, even if not specifically shown on the plans. Brackets, rails, bases, braces, etc., shall be provided as needed for a complete, high performing and safe installation.

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, manufacturers for products specified in this Section shall be one of the following:

1. Vibration Eliminator Co.
2. Mason Industries, Inc.
3. Kinetics Noise Control
4. Vibration Mounting and Controls (VMC)
5. Korfund
6. Vibration Isolation Co.
7. Amber Booth

2.2 FLEXIBLE DUCT CONNECTORS

A. Flexible sleeves for duct connections shall be fabricated from flexible, airtight, coated fabric. Each sleeve shall be at least 7 inches long and installed with at least 3 inches slack across a clear metal to metal gap of at least 4 inches.

2.3 FLEXIBLE METAL HOSE CONNECTORS

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

1. Metraflex
2. Flex Hose Co.
3. Flexonics
4. Mason Industries Inc.
5. Anaconda

B. Provide metal hoses with length and end fittings as shown on drawings, with an inner corrugated hose made of type 304, 321, or 316 stainless steel and outer braid made of 304 stainless steel.

C. For copper piping systems, use copper construction braided hoses.

2.4 FLEXIBLE PIPE CONNECTORS (RUBBER)

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

1. Mason Industries Inc. Type SFDEJ
2. Metraflex Type DS

B. Flexible connectors with neoprene and nylon type elements, with carbon steel or ductile iron floating flanges. Rated for 150 psig working pressure at 200ºF, with peroxide cured EPDM liner and cover, ultraviolet resistant, hand wrapped, non-molded, multiple arch body, with control rods or cables.

2.5 INERTIA BASES

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

1. Mason Industries, Inc.: Basis of design models noted below. Refer to Article 2.1 for approved equal manufacturers.

a. Type A: Model WFSL with unhoused spring isolators.
b. Type B: Model BMK/KSL with unhoused spring isolators.

B. All mounts shall have leveling bolts rigidly secured to the equipment being isolated.

C. Base Type A – Steel Inertia Base:

1. Shall be a structural steel base frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base.
2. Bases shall have built-in motor slide rails and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion. The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 4 inches for motors of 7.5 hp or less, 5 inches for motors between 7.5 hp and 20 hp and 6 inches for motors over 20 hp.

D. Base Type B – Concrete Inertia Base:

1. Shall have an integral rectangular structural steel form into which concrete is poured. Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 12 inches nor less than 6 inches deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
2. When the concrete base in “T” shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.

2.6 VIBRATION ISOLATORS

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

1. Mason Industries, Inc.: Basis of design models noted below. Refer to Article 2.1 for approved equal manufacturers.

a. Mounts:

1) Type 1: Model MSW
2) Type 2: Model ND
3) Type 3: Model SLF

b. Hangers:

1) Type 1: Model HD
2) Type 2: Model 30N

B. Isolator Mounts:

1. Type 1:

a. Waffle Pads shall be 3/8-inch-thick neoprene pads ribbed or waffled on both sides. The pads shall be manufactured with quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain. Where required, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad.
b. If the isolator is bolted to the structure, a neoprene mounting sleeve shall be installed under the bolt head between the steel washer and the base plate.

2. Type 2:

a. Shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
b. The isolator shall be manufactured with bridge bearing quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain. DDNM mounts shall be selected for a static deflection of 3/8 inch unless otherwise specified.

3. Type 3:

a. Shall have a free-standing and laterally stable steel spring without any housing. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall be not less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
b. Unless otherwise specified, the minimum static deflection of Type 3 isolators for equipment mounted on grade slabs shall be 1 inch and for the minimum static deflection for equipment mounted above grade level shall be 2 inches.
c. Two Type 3 isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bounded to the isolator baseplate.
d. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene mounting sleeve shall be installed under the bolt head between the steel washer and the base plate.

4. Type 4:

a. Laterally stable, restrained spring type with housings and heavy top plates for supporting the equipment and resisting seismic and wind loading. Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. Housings and springs shall be powder coated and hardware galvanized. The spring coil element shall be comprised of one or more coil assemblies having all of the characteristics of freestanding coil spring isolators.
b. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. All spring forces will be contained within the coil/housing assembly and under no seismic load condition shall the restraint anchoring hardware be exposed to spring generated forces. Top plate and restraining bolts shall be out of contact with the housing during normal operation.
c. The restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The restraint will allow a maximum of 1/4 in. (25 mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable.
d. The leveling nut or screw shall be accessible for adjustment with the use of a pneumatic or electric impact wrench. The spring element shall be replaceable without having to lift or otherwise remove the supported equipment.

C. Isolator Hangers:

1. Type 1:

a. Double Deflection Low Dynamic Stiffness Hangers shall consist of a molded low dynamic stiffness (LDS) isolating element in a steel hanger box. A LDS sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30° arc. When installed, the hanger box shall be allowed to rotate through a full 360° without encountering any obstructions.
b. The isolator shall be manufactured with quality LDS and selected for a maximum durometer of 50 and designed for 15% strain. Unless otherwise specified, the static deflection of Type 2 hangers shall be minimum of 0.3 inches.

2. Type 2:

a. Spring and Low Dynamic Stiffness Hangers shall consist of a steel spring in a series with a low dynamic stiffness (LDS) isolating element. The spring shall have a minimum additional travel to solid equal to 50% of the specified deflection. The neoprene element shall have a static deflection of not less than 0.3 inches with a strain not exceeding 15%.
b. Unless otherwise specified, the static deflection of SPH hangers shall be 2 inches.
c. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30° arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod. When installed the spring element shall not be cocked and the hanger box shall be allowed to rotate through a full 360° arc without encountering any obstructions.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment mounted on vibration isolators shall have a minimum operating clearance of 1 inch between the bottom of the equipment or inertia base and the concrete housekeeping pad (or bolt heads) beneath the equipment.

B. Provide a minimum of 4 inches between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.

C. Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes, or ductwork installed on vibration isolators.

D. Vibration isolator sizes and layout shall be determined by the vibration isolator supplier

E. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Equipment should be blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.

F. All mechanical equipment not specifically identified in this specification that contains rotating or vibrating elements shall be installed on Mount Type 2 neoprene isolators as appropriate. Provide supporting steel structure between isolators and equipment if isolator does not readily connect to equipment.

G. All equipment and their respective isolators shall be directly mounted on primary steel. Units and isolators shall not be mounted on resiliently supported steel cabinets or plenum floors or other flexible construction.

H. Roof mounted fans or roof top units shall be installed on a curb mounted base.

I. All wiring connections to mechanical equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 36-inch-long flexible conduit. Coordinate wiring connections with the Electrical Installer.

3.2 APPLICATION TABLES

Floor Mounted Equipment Type	Slab on Grade		Floor Span Up to 30 Feet		Floor Span 30 to 40 Feet	
	Base Type	Isolator Type	Base Type	Isolator Type	Base Type	Isolator Type
Fans:						
> 22” diameter and > 2” SP	B	Mount 2	B	Mount 3	B	Mount 3
Condensing Unit:						
All	Curb	Mount 1	Curb	Mount 1	Curb	Mount 1

“Floor Span”: Defined as the distance between centers of floor joists.

B. Suspended Equipment:

Equipment Type	Isolator Type
Pumps:	
Inline Pumps < 5 HP	Hanger 2
Fans (including Fan Coil Unit and Heat Pumps:	
< 22” diameter	Hanger 1
> 22” diameter and < 2” SP	Hanger 2
> 22” diameter and > 2” SP	Hanger 2

“Floor Span”: Defined as the distance between centers of floor joists.

3.3 PIPES WITH MULTIPLE CONNECTIONS

A. Where a pipe run connects multiple items of equipment in the Mechanical Room the pipe hanger isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

END OF SECTION 20 0548

SECTION 20 0553 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Provide Mechanical system identification for piping, valves, ductwork, architectural access panels and equipment.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.4 SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Brady Company
2. Brimer
3. Craftmark
4. MSI (Marking Services Incorporated)
5. Seton Name Plate Corporation

2.2 PIPE MARKERS

A. Manufacturer's standard, pre-printed, color-coded, plastic pipe markers, complying with ANSI A13.1, and requirements below. Self-adhesive markers are not acceptable.

B. For pipe diameter (with insulation) less than 6": full-band, semi-rigid, snap-on pipe markers, extending 360 degrees around pipe.

C. For pipe diameter (with insulation) of 6" and larger: full-band or strip-type pipe markers, but not narrower than 3 times letter height. Fasten with nylon or stainless steel bands for pipe 6" through 12". Fastened with stainless steel bands for piping over 12".

D. Lettering: Standard nomenclature which best describes piping system, as selected by Engineer (in cases of variance from table below).

E. Arrows: Pipe marker arrows indicating direction of flow, either integrally with piping system lettering, or as a separate marker.

F. Identify contents of piping by both fluid contained and unique temperature and /or pressure (if necessary, to distinguish between other systems with same fluid at different conditions); e.g. Potable Hot Water - 110F vs Potable Hot Water – 140F

G. Use the following color coding and nomenclature for pipe markers:

	Piping System	Label I.D.	Letter and Label Color
1.	Cold Water, Domestic	CW	White on Green
2.	Compressed Air	CA	White on Blue
3.	Fire Protection	FP	White on Red
4.	Hot Water, Domestic	HW	White on Green
5.	Hot Water Return, Domestic	HWR	White on Green
6.	Natural Gas	G	Black on Yellow
7.	Non-Potable Water	NPW	White on Green
8.	Sanitary Vent	V	White on Green
9.	Sanitary Waste	SAN	White on Green
10.	Storm Sewer Water	ST	White on Green
11.	Condensate Drain	COND	White on Green
12.	Hot Water Heating Supply	HWHS	White on Green
13.	Hot Water Heating Return	HWHR	White on Green

H. Underground Pipe Markers: Manufacturer's standard, permanent, bright-colored plastic tape, intended for direct-burial service, 6" wide x 4 mils thick, continuously printed to indicate service of buried pipe. For plastic pipe, provide label with detectable nonferrous locator.

2.3 DUCT MARKERS

A. Plastic, adhesive type color-coded duct markers, with arrow indicating direction of flow, and with fan system identified. Conform to the following color code and nomenclature:

	Service/Duct	Label I.D.	Letter and Label Color
1.	Supply Air (Eqpt #)	SA (Eqpt. #)	White on Green
2.	Return Air (Eqpt #)	RA (Eqpt #)	White on Blue
3.	Exhaust Air (Eqpt #)	EA (Eqpt #)	Black on Yellow
4.	Outdoor Air (Eqpt #)	OA (Eqpt #)	White on Blue
5.	Relief Air (Eqpt #)	RLF (Eqpt #)	White on Blue

B. Provide plastic adhesive duct access door markers indicating item and associated equipment accessed, and appropriate safety and procedural information. (eg. Fire Damper AHU-1)

2.4 EQUIPMENT MARKERS

A. Engraved plastic equipment markers for all scheduled equipment, (eg., chillers, pumps, air handling units, heat exchangers, fans, etc.). Indicate equipment mark and service, (eg. EF-1 Serving Toilet Rms 2035 & 2036; CHWP-1 Serving CH-1; AHU-1 Serving Flr 1 Offices) nominal capacity (tons, cfm or gpm). Scale marker and lettering to equipment labeled. White lettering on black background.

2.5 VALVE TAGS

A. 1-1/2" diameter brass valve tags with 1/4" stamp-engraved designations with piping system abbreviation and sequenced valve numbers. Provide solid brass chain, or solid brass S-hooks of the size and type required for proper attachment of tags to valves.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Install identification after insulation is applied. Protect identification from paint or apply after painting is complete. Install above ceiling identification prior to acoustical ceilings.

B. Attachment: Securely attach all mechanical identification to associated pipe, duct, panels and equipment. Locate identification to be readily visible.

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe markers on all piping systems in spaces where piping is exposed, concealed only by removable ceiling system, and where accessible at manholes and access panels.

B. Locate pipe markers near points where piping continues into shafts, underground, floor or wall; at 25' spacing along exposed runs (15' in congested areas), at valves, equipment and control devices, and where there could be question of flow pattern.

C. Install marker over pipe insulation segment on hot non-insulated pipes.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. During back-filling, install continuous underground pipe markers over all buried piping, 6" to 8" below finished grade. Where multiple pipes are in a trench up to 16" wide, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 DUCTWORK IDENTIFICATION

A. Install duct markers on all supply, return, exhaust, intake and relief ductwork where duct is exposed, concealed only by removable ceiling system, and where accessible at access panels.

B. Locate duct markers near points where ductwork originates or continues into shafts, floor or wall, and at 25' spacing along exposed runs.

C. Install duct access door markers on all access doors. Access doors for fire or smoke dampers shall be permanently identified on the exterior by a label having minimum 0.5 inch high lettering reading: FIRE/SMOKE DAMPER, SMOKE DAMPER or FIRE DAMPER.

3.5 EQUIPMENT IDENTIFICATION

A. Provide equipment markers on scheduled equipment.

3.6 VALVE IDENTIFICATION

A. Install valve tags on all new valves, except for check valves, valves within factory-fabricated equipment, plumbing fixture faucets, hose bibs, and valves located directly at the equipment served. Number valves in a logical sequence relative to location installed.

B. List each tagged valve in valve schedule for each piping system. Include a copy of the valve tag schedule in the Operation and Maintenance manuals and mount a laminated copy as directed by the Owner.

C. Where building has previously tagged valves, coordinate numbering with old schedule, and note changes made to previously tagged valves on new schedule.

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 20 0553

SECTION 20 0700 - MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Piping insulation materials and installation methods
2. Ductwork insulation materials and installation methods
3. Mechanical equipment insulation materials and installation methods
4. Ductwork acoustical lining materials and installation methods
5. Ductwork fire wrap materials and installation methods

1.3 ASBESTOS ABATEMENT

A. All asbestos within the contract bounds shall be removed per the requirements described in Division 02. Refer to drawings for items containing asbestos insulation. Re-insulate all piping, ductwork and equipment to remain from which asbestos has been removed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Codes and Standards

1. ASHRAE 90.1-2013

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

B. Protect materials against weather and contact with damp or wet surfaces from time of delivery through time of installation. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes.

C. Deliver materials only when environmental conditions meet requirements specified for installation areas. If materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

D. Do not store materials near other materials that may off-gas or emit harmful fumes, such as kerosene heaters, fresh paint, adhesives, etc.

E. When storing prior to installation, raise off floor on pallets, stack flat with protective material between to eliminate chance of creating nicks, scratches, and other imperfections and damage to finish surfaces, wrap weather-tight, and provide for air circulation within and around stacks and under temporary coverings.

F. Do not allow materials to become damp. Maintain temperatures at 60°F or higher, and humidity between 20% and 60% prior to, during and after installation.

1.6 SUBMITTALS

A. Product Data: Submit schedule indicating product used, where it is used, and thickness. For each type of product indicated, include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory and field applied if any).

PART 2 - PRODUCTS

2.1 GENERAL INSULATION REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Insulation thermal conductivity: No greater than value listed, in Btu-inch/hour-square foot-degrees F at 75 degrees F mean temperature.

C. Water Vapor Permeance (ASTM E97 or E96, Procedure A): No greater than value listed, in perms. Water vapor permeability (ASTM C355): No greater than value listed, in perm-inch.

D. Puncture resistance (ASTM D781): No less than value listed

E. Flame spread classification (ASTM E84, NFPA 255): No greater than value listed. Smoke density classification (ASTM E84, NFPA 255): No greater than value listed. Composite listing includes insulation, jacket, and adhesive.

F. Density no less than value listed, in pounds per cubic foot.

2.2 PIPING INSULATION – FIBERGLASS

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

1. Johns-Manville; Micro-Lok HP
2. Knauf; Earthwool 1000
3. Owens/Corning; ASJ/SSL-II

B. Fiberglass insulation with factory-applied vapor barrier jacket with self-sealing laps. ASTM C547 Class 1 insulation, conductivity of 0.23 at 75F. Vapor barrier jacket: laminated white kraft paper, aluminum foil, glass fiber reinforcement, water vapor permeance of 0.02 perms, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

2.3 PIPING INSULATION - CLOSED CELL ELASTOMERIC

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

1. Armacell; AP Armaflex
2. Aeroflex; Aerocel
3. K-Flex; INSUL-TUBE

B. Flexible closed cell elastomeric pipe insulation, ASTM C534, conductivity of 0.25, water vapor permeability of 0.20, composite flame spread/ smoke density of 25/50.

2.4 REFRIGERANT PIPING INSULATION – EPDM CLOSED CELL ELASTOMERIC

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

1. Armacell; AP Armaflex Black LapSeal
2. Aeroflex; Aerocell-SSPT
3. K-Flex; INSUL-LOCK DS

B. Flexible closed cell elastomeric tube insulation with self-seal, dual-tape closure. Thermal conductivity: 0.245; Water Vapor Transmission: 0.03, UV resistant, Temperature range: -40F to 250F, composite flame spread/ smoke density of 25/50.

2.5 PIPING INSULATION SPECIALTIES

A. PVC Jackets: Provide pre-molded, high impact, 20 mil thickness, UV resistant, 0-150F service temperature.

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

a. Zeston
b. Proto

B. Aluminum Jackets: Provide 0.016” thick alloy 3003 aluminum jacketing with longitudinal lock seam and butt strap circumferential joints.

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

a. Childers
b. Pabco

C. Removable Insulation Jackets: Provide removable insulation jackets with fiberglass insulation, flexible fabric jacket and Velcro fasteners.

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

a. Advance Thermal Corp
b. Q Master

2.6 DUCTWORK INSULATION – RIGID FIBERGLASS INSULATION BOARD

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

1. Johns Manville Type 817 Spin-Glas Insulation Board
2. Knauf Earthwool ASJ Insulation Board
3. Owens/Corning Type 705 ASJ-25 Insulation Board

B. Rigid fiberglass insulation board with factory-applied vapor barrier. Insulation: ASTM C612 Class 2, conductivity of 0.26, density of 3.0 pcf. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

2.7 DUCTWORK INSULATION – FIBERGLASS BLANKET

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

1. CertainTeed Type 75 FSK Standard Duct Wrap
2. Johns Manville R Series Microlite with FSK
3. Knauf Duct Wrap with Multi-Purpose FSK
4. Owens/Corning All Service Faced Duct Wrap.

B. Fiberglass blanket-type insulation with factory-applied vapor barrier, and 2" stapling and taping flange along one edge. Insulation: ASTM C553, density of 0.75 pcf, conductivity of 0.30. Vapor barrier: laminated white kraft paper, aluminum foil, glass fiber reinforcement, permeance of 0.02, and puncture resistance of 50 units. Composite flame spread/ smoke density of 25/50.

2.8 DUCTWORK INSULATION – CLOSED CELL ELASTOMERIC SHEET

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

1. Armacell AP Armaflex Sheet Insulation
2. Aeroflex; Aerocel
3. K-Flex; INSUL-SHEET

B. Closed cell elastomeric insulation sheet. ASTM C534, conductivity of 0.25, water vapor permeability of 0.05 perm-inch, composite flame spread/ smoke density of 25/50.

2.9 DUCTWORK JACKETING – SELF-ADHERING SHEET MEMBRANE

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

1. MFM Building Products Corp FlexClad-400
2. Other approved equivalent

B. Apply self-adhering sheet-type membrane over rigid board insulation for weatherproofing.

C. Submit manufacturer’s data sheets, preparation instructions/recommendations, installation methods, and manufacturer’s certification letter that materials comply with specified requirements and are suitable for intended application. (Should be under 1.6 Submittals if kept)

D. Membrane General: Prefabricated self-adhering, sheet-type protective membrane. The outer layer is an embossed, UV-resistant aluminum weathering surface. Under the aluminum are multiple layers of high-density cross-linked polymer film. Under the polymer film is a uniform layer of rubberized asphalt adhesive which sticks directly to metal, insulation faces and most other clean, dry surfaces.

E. Release liner: The self-adhesive surface is protected by a disposable release liner.

F. Technical Properties:

1. Material Thickness (ASTM D 1970): 45 Mils (1.0 mm) Nominal
2. Flexibility at -20 degrees F (-29 degrees C) (ASTM D 1970): Pass
3. Vapor Permeance (ASTM E 96): .01 perms
4. Nail Sealability (ASTM D 1970): Pass
5. Heat Aging (ASTM D 794): Pass
6. Elongation (ASTM D 412): 450 percent
7. Tear Resistance (ASTM D 1424): 660 grams
8. Meets 25/50 Flame/Smoke Rating (ASTM E 84)
9. Maximum Temperature: 175 degrees F (79 degrees C)
10. Installation Temperature Range: Greater than 40 degrees F (4.5 degrees C)

2.10 EQUIPMENT INSULATION – CLOSED CELL ELASTOMERIC SHEET

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

1. Armacell AP Armaflex Sheet Insulation
2. Aeroflex; Aerocel
3. K-Flex; INSUL-SHEET

B. Closed cell elastomeric insulation sheet. ASTM C534, conductivity of 0.25, water vapor permeability of 0.05 perm-inch, composite flame spread/ smoke density of 25/50.

C. Elastomeric insulation sheet contact adhesive.

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

a. Armacell; Armaflex 520 Adhesive
b. Aeroflex; Aeroseal
c. K-Flex

2.11 SEALING MASTICS FOR PIPE AND DUCT INSULATION

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

1. Childers
2. Foster
3. Vimasco
4. Mon-Eco Industries

B. Provide mastics to seal insulation joints and to provide a continuous vapor barrier. The permeance of the mastic shall be equal to or less than the permeance of the vapor barrier of the insulation it is applied to. The ASTM E84 flame spread and smoke density classification shall not exceed 25/50. Mastics shall be mercury and asbestos free, selected for the temperature range of the service, and selected for uses recommended by the manufacturer. Mastics used outdoors shall be outdoor rated, waterproof, and U.V. resistant.

2.12 DUCTWORK ACOUSTICAL LINING – CLOSED CELL ELASTOMERIC DUCT LINER

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

1. Armacell AP Armaflex SA Black Duct Liner
2. Aeroflex; Aerocel AC
3. K-Flex; DUCT Liner Gray

B. Closed cell elastomeric duct liner. ASTM C177 or C518, conductivity of 0.27. Water vapor permeability of 0.08 per ASTM E 96 Procedure A. Composite flame spread/ smoke density of 25/50.

PART 3 - EXECUTION

3.1 INSULATION GENERAL REQUIREMENTS

A. Insulate piping, ductwork and equipment unless indicated as not to be insulated in subsequent paragraphs.

B. Insulate connection points between new and existing items.

C. Repair or replace insulation damaged during construction.

D. All systems shall be tested and approved before being insulated.

E. The insulation shall be applied over clean, dry surface.

F. Full lengths of insulation shall be used except at end of straight sections and as required to accommodate fittings. Insulation shall be applied with the joints tightly fitted together. Cracks or voids shall be filled with insulation. The edges and seams at all visible locations shall be finished in a neat and workmanlike manner. Manufacturer's recommended installation procedures shall be strictly adhered to.

3.2 PIPING INSULATION THICKNESS TABLE

Minimum insulation thickness in inches, shall comply with the table below for the associated piping system and pipe sizes. Values are based on an R value of 4 per inch thickness. Overall conductance shall comply with ASHRAE 90.1

System Description	Temp Range Deg F	<1”	Thru 1-1/4”	Thru 3”	Thru 6”	8” & above
Hot Water	141-200	1.5	1.5	2.0	2.0	2.0
Hot Water	105-140	1.0	1.0	1.5	1.5	1.5
Cold Water & Coil Condensate	Any	0.5	0.5	0.5	0.5	0.5
Storm (horizontal piping only)	Any	0.5	0.5	0.5	0.5	0.5
Refrigerant Suction	Any	1.0	1.5	1.5	---	---

3.3 PIPING INSULATION APPLICATION

A. Piping-Indoor:

1. Type: Fiberglass
2. Thickness: See Piping Insulation Thickness Table
3. Jacket: Factory ASJ

B. Piping-Outdoor:

1. Type: Fiberglass or Closed Cell Elastomeric
2. Thickness:

    a. For outdoor piping systems with fluid temperature above 200 deg F, apply insulation 1/2" thicker than listed in Piping Insulation Thickness Table
    b. For outdoor piping systems with fluid temperature at or below 200 deg F, apply insulation in the same thicknesses listed in Piping Insulation Thickness Table

3. Jacket: Aluminum.

C. Refrigerant Piping - Outdoor:

1. Type: Closed Cell Elastomeric
2. Thickness: 1” for risers in vertical pipe chase, 3/4” for all branch piping outside pipe chase
3. Jacket: Aluminum.
4. Workmanship: It is imperative that sealing of the seams be done in a careful manner to ensure integrity of the vapor barrier. In that regard, provide adhesive taping at all seams in addition to mfr’s integral seam sealing system. Ensure no air gaps between insulation and the piping. Ensure all transverse and longitudinal seams are carefully taped. For all outdoor piping, ensure all longitudinal seams are turned down.

D. Piping Items not to be Insulated:

1. Unions
2. Flexible connectors, flexible metal hose, flexible neoprene hose
3. Control valves 2” and smaller
4. Safety valves
5. Discharge vent piping
6. Vacuum breakers
7. Sanitary, waste and vent piping
8. Compressed air piping
9. Natural gas piping
10. Refrigerant liquid lines
11. Vertical portion of rain water conductors
12. Below-grade piping, unless otherwise indicated
13. Chrome-plated pipes and fittings, unless potential for personnel injury
14. Air Chambers

E. At fittings and flanges, insulate with wrapped fiberglass insulation of same thickness as adjacent pipe, and cover with pre-molded PVC jackets. Seal edge of jacket with self-sealing vapor barrier tape.

F. For valves, strainers, suction diffusers and other accessories that require maintenance: In hot piping, insulate similar to fittings and flanges. In cold piping, insulate with closed cell elastomeric insulation, installed to be removable for maintenance access.

G. Wherever necessary to seal insulation and provide a complete and continuous vapor barrier, apply two coats of insulating mastic

H. For closed cell elastomeric insulation, seal all butt joints and seams by joining cut edges with adhesive as supplied by the insulation manufacturer

I. Expansion Joints Insulation: Expansion joints shall be insulated with prefabricated insulation blankets, installed in a manner to allow for the repacking of the joints without removing blanket. Hold blankets in place with permanently attached Velcro fasteners

J. Removable Insulation Jackets: Where indicated on drawings, provide removable insulation jackets.

3.4 DUCTWORK INSULATION APPLICATION

A. Ductwork – Indoor Exposed: In mechanical equipment rooms and all other areas where visible without removing ceilings or opening access panels.

1. Type: Rigid Fiberglass Insulation Board
2. Thickness: 1-1/2”
3. Jacket: Factory ASJ

B. Ductwork – Indoor Concealed: In ceiling spaces, building shafts, and other locations where not visible

1. Type: Fiberglass Blanket
2. Thickness: 1-1/2”
3. Jacket: Factory FSK

C. Ductwork – Outdoor

1. Type: Rigid Fiberglass Insulation Board or Closed Cell Elastomeric Sheet
2. Thickness: 1-1/2”
3. Jacket: Self-Adhering Sheet Membrane

D. Ductwork Items Not To Be Insulated:

1. Indoor return air ductwork in conditioned areas
2. Exhaust air ductwork (insulate indoor duct between damper and exterior of building)
3. Exhaust air plenums (insulate indoor plenum between damper and building exterior)
4. Economizer relief air ductwork (insulate indoor duct between damper and building exterior)
5. The following spaces are normally considered conditioned areas: return air plenums above ceilings, heated penthouse, mechanical and electrical rooms

E. All exposed ductwork insulation shall be applied with edges butted. Insulation shall be impaled over stick clips or pins welded to the duct and secured with speed clips. Spacing of pins shall be as required to hold insulation firmly in place but not less than one pin per square foot. All joints and penetrations of the vapor barrier shall be sealed with a 3" wide strip of the same material, supplied with vapor barrier adhesive to both surfaces as recommended by adhesive manufacturers.

F. Blanket insulation shall be tightly sealed at all joints and seams. Insulation shall be cut longer than ductwork perimeter to allow maximum thickness on all areas and to avoid excessive compression. All joints shall be over-lapped at least 2" and stapled in place. The stapled seams shall be sealed with a minimum 3" wide pressure sensitive tape designed for use with the duct insulation. All breaks in the vapor barrier facing shall be sealed with the tape. The underside of ductwork 18" or greater in width, and vertical surfaces 48" or greater shall have the insulation additionally secured with mechanical fasteners and speed clips spaced approximately 12" on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then sealed with the same tape as specified above.

3.5 HOT EQUIPMENT INSULATION APPLICATION

A. Hot Equipment Insulation

1. Type: Rigid Fiberglass Insulation Board
2. Thickness: See Below
3. Jacket: None for indoor equipment, PVC for outdoor equipment

B. Insulate all equipment with surface temperature over 100F.

C. Apply insulation in thickness as follows:

1. 1-1/2" for operating temperature up to 150F
2. 2" for operating temperature of 150F to 200F
3. 3" for operating temperature over 200F

D. Cut, score, or miter insulation to fit contour of equipment and secure with galvanized steel bands or wire, or weld pins. Stagger joints where possible and fill voids with insulating cement. Apply 1" galvanized wire mesh over entire exterior surface and finish with two coats of insulating cement troweled to a hard finish.

E. Hot Equipment Not To Be Insulated:

1. Hot water pumps
2. Steam condensate pumps
3. Boiler feedwater pumps
4. Heating hot water system chemical shot feeders
5. Domestic water or heating hot water expansion tanks

3.6 COLD EQUIPMENT INSULATION APPLICATION

A. Cold Equipment Insulation

1. Type: Closed Cell Elastomeric Sheet
2. Thickness: 1”
3. Jacket: None for indoor equipment, PVC for outdoor equipment

B. Insulate all equipment with surface temperature below 60F.

C. Apply elastomeric insulation sheet with contact adhesive

D. Cold Equipment Not To Be Insulated:

1. Water softener shells
2. Vacuum pumps
3. Factory insulated equipment
4. Vibration-control devices

3.7 DUCTWORK ACOUSTICAL LINING APPLICATION

A. Ductwork Acoustical Lining

1. Type: Closed Cell Elastomeric Duct Liner
2. Thickness: 1”
3. Jacket: None

B. For the first 10 feet of supply air ductwork connected to equipment, acoustically line the duct with 1” closed cell elastomeric duct liner if indicated on the Drawings.

C. For the first 10 feet of return air ductwork connected to equipment (and for the return air boot for heat pumps that have no return air ductwork), acoustically line the duct or return air boot with 1” of closed cell elastomeric duct liner if indicated on the Drawings.

D. Other locations indicated on the Drawings.

END OF SECTION 20 0700

SECTION 20 1100 - PLUMBING AND HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies pipe materials, fittings, joining methods, piping specialties and installation methods. In addition, pressure testing and flushing/cleaning procedures are outlined.

1. Plumbing piping systems
2. Hydronic piping systems
3. Refrigerant piping systems
4. Pipe joints
5. Mechanically formed tee connections in copper piping
6. Unions
7. Pipe sleeves
8. Dielectric fittings
9. Strainers
10. Pipe anchors
11. Piping transitions
12. Pipe sleeve seal systems

1.3 SUBMITTALS

A. Product Data: Include manufacturer, catalog illustrations, model, rated capacities, performance, dimensions, component sizes, rough-in requirements, materials of construction, and operating and maintenance clearance requirements. Additionally include:

1. Provide a piping material schedule that indicates, by service, pipe material, pipe manufacturer, fitting type and manufacturer, joint type and manufacturer.
2. Solder and brazing material data sheets.
3. Grooved fittings, couplings, and accessories data sheets.
4. Data sheets for all products listed in this section including fittings, flanges and gaskets.
5. For underground pressurized and steam condensate piping systems, provide a simplified drawing of the piping system identifying pipe depth and slope, location and type of each joint and restraint, valve, and similar accessories, and dimensions of any expansion loops

1.4 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. All piping, (including vacuum piping), unless noted otherwise, shall comply with ANSI Standard B31.9 - Building Service Piping.
2. All steam piping above 15 psig, and all steam condensate piping shall comply with ANSI Standard B31.1 - Power Piping.
3. National Sanitation Foundation NSF/ANSI-61, including Annex G (listed as ≤ 0.25% weighted average lead content)(and/or NSF/ANSI-372)and Annex F. Applies to any item in contact with domestic (potable) water.

4. U.S. Safe Drinking Water Act (any item in contact with domestic (potable) water)
5. AWWA C600 Standard for Installation of Ductile-Iron Water Mains and their Appurtenances.
6. AWWA C606 Grooved and Shouldered Joints.
7. Mill certifications indicating country of origin and compliance to ASTM/ANSI/NSF and other required compliance standards verified by independent third party based in the United States shall be promptly provided whenever requested.
8. NFPA 54 - National Fuel Gas Code

C. Regulatory Requirements For Refrigerant Piping Systems: Comply with provisions of the following codes:

1. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
3. ASHRAE Standard 34: Number Designation and Safety Classification of Refrigerants.
4. EPA requirements in Section 608: Prohibition of Venting and Regulation of CFC Requirements.
5. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves".

D. Regulatory Requirements For Natural Gas Piping Systems: Comply with provisions of the following codes:

1. Comply with the requirements of NFPA 54 - National Fuel Gas Code, for gas piping materials and components, and gas piping systems installation, inspection, testing, and purging.

E. Regulatory Requirements For Steam and Condensate Piping Systems: Comply with provisions of the following codes:

1. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications".
2. ASME Compliance: Comply with ASME B31.1, "Power Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store piping materials and accessories off the floor/ground on pallets and protected with coverings to prevent damage or contamination due to weather and construction activities. Provide temporary protective caps on pipe ends. Maintain caps installed at all times until just prior to assembly, and recap open pipe ends at the conclusion of each work day. Store in areas that prevent damage due to freezing and extreme temperatures or sunlight. Arrange coverings to provide air circulation to avoid damage from condensation or chemical build-up. Protect from damage, dirt and debris at all times.

1.6 WARRANTY

A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL PIPING REQUIREMENTS

A. See Part 3 for application of piping type and material.

B. All piping materials shall be compatible for temperature, pressure and service.

C. Provide long radius elbows and returns on welded steel pipe.

2.2 PIPE JOINTS

A. Soldered Joints: ASTM B32; Alloy Sb5, (95% Tin, 5% Antimony, maximum 0.20% Lead). When recommended by the component manufacturer, use manufacturer's recommended flux. Unless noted otherwise, joints may be screwed or flanged to suit valves and equipment. Manufacturers: Engelehard "Silverbrite 100", Harris "Bridgit"

B. Brazed Joints: ASTM B32, silver brazed joints with 1000F minimum melting point, conforming to AWS - A5.8, "Specification for brazing filler metal". Classification BAg-1. For domestic potable water applications, maintain a nitrogen purge during brazing to prevent deposit formation inside the pipe. Unless noted otherwise, joints may be screwed or flanged to suit valves and equipment. Manufacturers: Lucas-Milhaupt Inc. "Sil-Fos", J.W. Harris "Stay-Silv 15" and "Safety Silv"

C. Screwed Joints: Tapered thread, ASME B1.20.1, joined with compatible compound or sealant tape applied to male thread only.

D. Welded Joints: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded. Pipe and fittings shall be beveled and butt welded.

E. Press Joints:

1. Limited to a maximum pipe size of 4".
2. Rated for a minimum 200 PSI working pressure from -4ºF to 250ºF.
3. Compatible with seamless type K, L, and M copper tube conforming to ASTM B88.
4. Fittings shall be a minimum 78% copper and a maximum of 15% zinc, alloyed to prevent dezincification.
5. Fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.12.
6. Seals/O-rings shall be peroxide cured EPDM.
7. Joints shall be pressed using the tool approved by the manufacturer.
8. Provide press fittings from the same manufacturer for the entire scope of the work, for each system.
9. For piping 2" and smaller, non-fitting components such as valves, strainers, check valves, etc. manufactured by the press fitting manufacturer may be used provided:

    a. the press fitting manufacturer is approved for those components elsewhere in the specifications
    b. such components fully comply to the requirements of the respective specification section for the component.

10. Approved fitting, tool, and process:

    a. Viega ProPress
    b. NIBCO Press System.
    c. Apollo Xpress

G. Flanged Joints:

1. Select flange and gasket materials to suit service of piping and to comply with the respective ASME B31.1 or B31.9 piping standard.
2. For steel pipe, provide raised face ANSI B16.5 compliant steel flanges.
3. For copper pipe, provide Class 150 flat face ANSI B16.24 cast bronze flanges, brazed to the copper tube.

    a. Alternative: Copper companion flange by CTS Fabrication USA rated 450 PSI minimum working pressure from -66ºF to 272ºF. ANSI B16.5 compliant, powder coated, with an EPDM insulator adhered to the plate steel flange protruding inside of the flange to prevent

contact with the copper companion flange adapter. Flange adapter shall be manufactured to ASME B16.22, brazed to the copper tube.

4. Gaskets shall conform to respective ANSI Standards, A21.11, B16.20, B16.21. Gaskets in steam and condensate lines shall be “FLEXTALLIC”, 316 L stainless steel with “FLEXICARB” filler. Flange gaskets for domestic hot water shall be 100% PTFE. For butterfly valves on replaceable seat side with interfering set-screws, provide Garlock Style 9800.
5. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Central Power Plant and Tunnels: Provide ASTM A193 B7 bolts and studs with ASTM A194 grade 2H heavy hex nuts.

H. Hubless Joints for Cast Iron No-Hub Pipe: Heavy duty ASTM C1540 couplings with stainless steel shield with stainless steel bands and tightening devices, ASTM C564 rubber sleeve with integral center pipe stop.

1. When connecting cast iron no-hub pipe to dis-similar pipe: Provide ASTM C1460 couplings specifically designed for both pipe types, with stainless steel shield with stainless steel bands and tightening devices, with ASTM C564 rubber sleeve with integral center pipe stop. Unshielded couplings shall not be used. Connections between dis-similar pipe materials shall be restrained. Submit coupling and restraint methods for approval
2. Approved Manufacturers:

a. Anaco/Huskey
b. Clamp-All Corp.
c. Fernco Inc.
d. Ideal Tridon
e. Mission Rubber Company (MCP Industries Inc.)

I. Gasket Joint Lubricant - for use with grooved and hubless joints: Provide manufacturer’s recommended gasket lubricant.

J. Solvent Cement Joints: Select materials suitable for pipe materials joined and compatible with fluid served. Conform to respective ASTM Standards D-2235, D-2564, D-2855 and D-3138.

2.3 MECHANICALLY FORMED TEE CONNECTIONS IN COPPER PIPING

A. Contractor may use mechanically formed Tee connections in copper piping in lieu of tee fitting only where main piping is 2 1/2" or larger and where branch connection is 3/4" or smaller. Joint must be brazed. Tool manufacturer: T-Drill.

2.4 UNIONS

A. Unions in steel piping systems shall be malleable iron with ground joints made between two bronze inserts.

B. Unions in copper piping systems shall be wrought copper or brass with sweat ends.

2.5 PIPE SLEEVES

A. Provide pipe sleeves where required, including the following locations:

1. Where required by code
2. Where required as part of rated penetration, to maintain fire and smoke rating
3. To support vertical piping (to support riser clamps)
4. Where required to maintain water seal and prevent water penetration
5. Where pipe movement is anticipated (especially due to thermal expansion) at the penetration

B. Fire protection piping, compressed air piping and other un-insulated piping: Sleeves are generally not required, unless required to maintain integrity of rated walls or floors.

C. Cold water: Sleeves are required for all piping 2” and larger penetrating walls and floors.

D. Heating hot water and other hot insulated piping: Sleeves are required for all piping penetrating walls and floors

E. For underground exterior wall penetrations, piping penetrations must be watertight. For new construction, provide cast-in-place sleeve with integral water-stop, oversized for the use of a pipe sleeve seal.

2.6 DIELECTRIC FITTINGS

A. For pipe 2 inch and less: Provide brass coupling. (Dielectric unions are not acceptable).

B. For pipe 2-1/2 inch and larger: Provide flange union with dielectric gasket and bolt sleeves. On copper pipe, copper companion flanges by CTS Fabrication USA shall be used.

C. Dielectric waterways are prohibited for all joint systems.

2.7 STRAINERS

A. Body shall be bronze, cast steel or cast iron, to match piping materials. Strainers shall be same size as piping, with screwed connections on piping 2” and smaller, and flanged connections on piping 2-1/2” and larger. Where grooved piping is specified, grooved joint strainers may be used. Screen free area shall be a minimum of twice the internal cross sectional area of the piping where installed. Pressure rating shall be that of piping system, minimum Class 125. Provide 3/4” ball valve blow down with hose end connection on all strainers 2” and larger.

B. For water service, screen material stainless steel, with maximum openings of 1/16 (0.062) inches for pipes 2” and smaller and 1/8 (0.125) inches for pipe sizes 2-1/2” and larger.

C. For gas service, screen material stainless steel, with maximum openings of 0.006 inches for pipes 2” and smaller and 0.009 inch for pipe sizes 2-1/2” and larger.

D. Approved Manufacturers: Armstrong, Anvil International, Keckley, Metraflex, Mueller, Spirax-Sarco, Victaulic, Watts, Yarway.

2.8 FLEXIBLE PIPING CONNECTORS

A. Refer to Section 22 0548 Vibration Control

2.9 PIPE ANCHORS

A. Provide pipe anchors where shown and as detailed on drawings.

2.10 PIPING TRANSITIONS

A. For dissimilar metal connections, see “Dielectric Fittings”.

B. When two different pipe materials must be joined such as cast iron, clay, steel, copper or plastic, provide transition fittings specifically designed for that purpose and that are manufactured in compliance with the standards relevant for the pipes joined. Transitions shall have equal corrosion resistance to the pipes joined.

2.11 PIPE SLEEVE SEAL SYSTEMS

A. Approved Manufacturers:

1. EnPro Industries “Link Seal”

2. Advance Products & Systems, Inc.
3. Metraflex Company.
4. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve. Shall provide a water-proof seal between the pipe and sleeve at up to 20 psig head pressure. Each link and pressure plate shall include permanent identification of size and manufacturer's name. Manufactured in an approved ISO-9001:2000 facility.

C. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe.

D. Pressure Plates: Molded of glass reinforced nylon.

E. Connecting Bolts and Nuts: Mild steel with a 60,000 psi minimum tensile strength and 2-part Zinc Dichromate coating per ASTM B-633 and Organic Coating, tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test. Of length required to secure pressure plates to sealing elements.

F. Sleeves:

1. Galvanized steel, ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar, zinc coated. Steel Sleeve sizes 12” and larger shall be 0.375” thick or standard pipe wall thickness. Sleeves through wall shall be cast in place and the pipe shall be installed centered in the sleeve. Provide 2” collar (water-stop) of steel to match sleeve, welded all around on both sides to the sleeve at the point on the sleeve that positions it at the mid-point of the structural wall when the sleeve is in place.
2. Molded non-metallic high density polyethylene sleeves (HDPE) with integral hollow, molded water-stop ring four inches larger than the outside diameter of the sleeve itself. End caps and reinforcing ribs, manufactured in an approved ISO-9001:2000 facility.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Work shall be done in accordance with applicable ordinances and codes. Arrange for inspections.

B. For domestic potable water applications, maintain a nitrogen purge during brazing to prevent deposit formation inside the pipe, so that the inner pipe surface remains clean. Properly ventilate the area outside the pipe to avoid unsafe levels of nitrogen.

C. Install pipe components and joining systems in accordance with the manufacturer's installation instructions.

D. Install piping to permit complete draining. Provide capped hose end ball type drain valves at all low points.

E. If water (flushing water, blow down, etc.) or hydronic system fluids have a pH between 5.0 and 10.0 and meet the requirements of the local municipality Sewer Use Ordinance, it may be discharged to the sanitary sewer. If the water does not meet the sewer discharge limits, then provide for alternate disposal means approved by local and state jurisdictions.

F. Installed piping shall be free from sagging. Provide for expansion and contraction of piping in an approved and safe manner by means of loops or offsets, where mechanical expansion joints are not specifically called for.

G. Branch connections from horizontal steam, steam condensate, and gaseous system mains shall be taken off the top, up at a 45 degree angle, or off the side.

H. Branch connections from horizontal hydronic system mains shall not be taken off the main bottom, or at less than 45 degrees from horizontal.

I. Branch piping shall be valved at the branch connection points.

J. Provide fittings and specialties necessary to properly interconnect all items, whether or not shown in detail.

K. Piping shall remain protected and capped until just prior to connection. Immediately after assembly, restore all protection and cap unprotected ends to prevent odors, dust, moisture, and other debris from entering the piping system.

L. Clean and swab-out all piping before installation.

M. Lay out pipe lines straight, plumb and in true alignment. Offset as required to avoid interference with other work, to conceal piping, to allow maximum headroom and to avoid interference with windows and doors. Lay out all pipes and establish their levels from bench marks, existing floors or finished grades.

N. Piping shall be concealed unless indicated otherwise on drawings. Do not conceal piping until it has been inspected, tested, flushed and approved.

O. Use eccentric reducing fittings to increase or decrease pipe sizes. Bushings are not acceptable. Orient reducers to prevent trapping of water.

P. Lubricate flange bolts and install with hardened flat washers. Use a torque wrench to tighten flange bolts to the gasket manufacturer's recommended torque.

Q. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing of valves. Install hot and cold water lines at least 6 inches apart.

R. Install piping at least 3 inches clear of electrical conduit. Do not install pipe within the National Electrical Code (NEC) working space zone of electrical equipment. Examples:

1. Above the footprint of electrical equipment in the zone extending 6' above the installed height of the equipment.
2. Within the NEC working space in front of the electrical equipment. NEC working space varies depending on voltage and other factors. Typically for equipment 600 volts or less it extends from the floor to the height of the equipment or 6'-6", whichever greater, 3'-6" in front of the equipment, and for the width of the equipment or 30", whichever is greater.
3. Verify NEC clearance requirements prior to installing work. Note that variable frequency drives are considered electrical equipment.

S. Pipe extending into finished areas shall have chrome plated escutcheons large enough to cover pipe sleeves and shall fit snugly over pipe or insulation.

T. Pitch piping as follows, but not less than required by code:

1. Hydronic piping up in direction of flow at 1/16" per foot
2. Steam piping down in direction of flow at 1/16" per foot
3. Vent piping back toward waste at 1/16" per foot
4. Waste, condensate and compressed air piping down in direction of flow at 1/8" per foot.

U. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

1. Support vertical pipe at no less than every floor level, at the base of each riser, and at every riser offset.

2. Support horizontal pipe 5" diameter and greater with a minimum of two pipe hangers between couplings, except sections of pipe less than 4 feet in developed length are permitted to be supported with no less than one hanger between couplings.
3. All horizontal piping 5" diameter and greater shall be restrained or braced to prevent movement at each joint at every direction change and at each branch connection.
4. Provide pipe hangers to support every horizontal branch connection; provide sway bracing when pipe is suspended in excess of 18" by non-rigid hangers, and comply with all other bracing, support, and installation recommendations and suggestions in the CISPI Handbook.
5. Provide hangers and supports to eliminate all misalignment at couplings.
6. Tighten all clamps to coupling manufacturer's recommended torque, using a torque wrench.
7. Joints between dissimilar pipe materials shall be restrained

V. Sanitary and storm piping shall be anchored upstream of the first coupling at the point of building exit (interior side) to prevent movement due to back surges, by permanent blocks, bracing, threaded rodding anchored to the exterior wall, or other suitable means.

W. Pipe Sleeves: Furnish and set pipe sleeves per details on drawings

X. Pipe Anchors: Furnish and install pipe anchors where shown and as detailed on drawings

3.2 PLUMBING PIPING SYSTEMS APPLICATION

A. Domestic Cold Water, Hot Water and Hot Water Return - Above Ground (including non-potable)

1. For piping through 6”:

a. Pipe: Type L Copper, hard drawn, ASTM B88
b. Fittings: Wrought Copper, ANSI B16.22
c. Joints:

1) Soldered: through 2”
2) Brazed: for 2-1/2” through 6”
3) Press-to-Connect: for cold water, hot water and hot water return piping through 4", may be used excluding inaccessible locations.

B. Domestic Cold Water - Under Ground (including non-potable)

1. Tubing: Viega PEX Ultra, Type b, 1/2-inch thru 2-inch shall conform to, ASTM F876, ASTM 877, ASTM E84, ASTM E119-14, CSA 137.5, NFPA 251, NSF 61, NSF 372, UBC 7-1, and UL 263. Viega PEX Ultra tubing shall have a Standard Dimensional Ratio (SDR-9), with 100 psi at 180°F / 160 psi at 73°F pressure rating, a “5006” or CL 5 chlorine listing and a 5306, or 3 ultraviolet UV exposure listing. Tubing distribution should be made through a Viega ManaBloc / MiniBloc Home-run System and shall conform to ASTM F877, NSF Standards 14 & 61, CSA B137.5 and have a UPC Certification
2. Fittings - none, continuous piping

C. Compressed Air - Above Ground

1. For piping through 6”:

a. Pipe: Type L Copper, hard drawn, ASTM B88
b. Fittings: Wrought Copper, ANSI B16.22
c. Joints:

1) Soldered: through 2”
2) Brazed: for 2-1/2” through 6”

2. For piping through 2” in areas subject to physical abuse:

   a. Pipe: Black Steel, Schedule 40, ASTM A53 ERW or seamless grade B
   b. Fittings: Malleable iron 150 lb ASTM A 197; unions: 250 lb ASTM A 197
   c. Joints: Screwed

D. Sanitary Waste and Vent - Above Ground

1. For piping through 12”:

   a. Pipe: Cast Iron, Service Weight, CISPI Standard 301, ASTM A74, ASTM A888
   b. Fittings: Cast Iron, drainage pattern, ASTM A74, ASTM C564
   c. Joints: Hubless - Heavy duty, ASTM C1540 shielded couplings

E. Sanitary Waste and Vent - Under Ground

1. For piping through 12”:

   a. Pipe: Cast Iron, Service Weight, CISPI Standard 301, ASTM A74, ASTM A888
   b. Fittings: Cast Iron, drainage pattern, ASTM A74, ASTM C564
   c. Joints: Hubless - Heavy duty, ASTM C1540 shielded couplings

2. For piping through 12”:

   a. Pipe: PVC Schedule 40, ASTM D 2665, NSF approved, type DWV
   b. Fittings: PVC, ASTM D 3311
   c. Joints: Solvent weld, ASTM D2564

F. Equipment Condensate Drains, including coils and energy recovery devices - Above Ground

1. For piping through 6”:

   a. Pipe: Type DWV Copper, hard drawn, ASTM B306
   b. Fittings: Wrought Copper, ANSI B16.22
   c. Joints: Soldered

G. Storm - Above Ground

1. For piping through 12”:

   a. Pipe: Cast Iron, Service Weight, CISP Standard 301, ASTM A74, ASTM A888
   b. Fittings: Cast Iron, drainage pattern, ASTM A74, ASTM C564
   c. Joints: Hubless - Heavy duty, ASTM C1540 shielded couplings

H. Storm – Under Ground

1. For piping through 12”:

   a. Pipe: Cast Iron, Service Weight, CISP Standard 301, ASTM A74, ASTM A888
   b. Fittings: Cast Iron, drainage pattern, ASTM A74, ASTM C564
   c. Joints: Hubless - Heavy duty, ASTM C1540 shielded couplings

2. For piping through 12”:

   a. Pipe: PVC Schedule 80, ASTM D 2665, NSF approved, type DWV
   b. Fittings: PVC, ASTM D 3311
   c. Joints: Solvent weld, ASTM D2564

3.3 HYDRONIC PIPING SYSTEMS APPLICATION

A. Heating Hot Water

1. For piping through 4":

a. Pipe: Type L Copper, hard drawn, ASTM B88
b. Fittings: Wrought Copper, ANSI B16.22
c. Joints: Soldered through 2"; Brazed for 2-1/2" through 4"

2. For piping 5" and larger:

a. Pipe: Black Steel, Schedule 40, ASTM A53, ERW or seamless, grade B, standard weight for 12" and above
b. Fittings: Standard weight, butt welded, black steel, ASTM A234
c. Joints: Welded. Flanged ASTM A181, 150#, forged steel at valves, and equipment.

3.4 NATURAL GAS PIPING APPLICATION

A. Natural Gas - Above Ground

1. For piping through 2":

a. Pipe: Black Steel, Schedule 40, ASTM A 53, ERW or seamless, grade B
b. Fittings: Malleable iron, 150 lb ASTM A 197; unions, 250 lb ASTM A 197
c. Joints:

1) Screwed Terminal Connections: for 1/2" and less Type L Copper, annealed, ASTM B 88, 24" maximum length, flared connections.

2. For piping 2-1/2" and larger:

a. Pipe: Black Steel, Schedule 40, ASTM A 53, ERW or seamless, grade B, standard weight for 12" and above
b. Fittings: Standard weight, butt welded, black steel, ASTM A 234
c. Joints: Welded. Flanged ASTM A 181, 150#, forged steel at valves, and equipment.

3.5 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

A. Install, inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

B. Gas meter, pressure regulator and related valves and trim shall be furnished and installed by the Local Utility. All gas piping outside the building, upstream of the gas meter shall be provided and installed by the Local Utility. Contractor shall coordinate the installation of gas meter and related components with the Local Utility and the Owner. Expenses and fees for Local Utility Work shall be paid for by the Owner.

C. See Section 22 05 23 for valve specifications and installation requirements.

D. Gas piping in Floors: Gas piping with welded joints and protective PE wrapping may be installed in floors, subject to approval of authorities having jurisdiction. Surround piping cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate

E. Gas piping In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside hollow partitions or hollow walls

F. Gas piping In Masonry Walls: Gas piping with welded joints and protective PE wrapping may be installed in masonry walls, subject to approval of authorities having jurisdiction

G. Drips and Sediment Traps: Install a drip leg at inlet to terminal equipment, points where condensate may collect, and at the outlet of the gas meter. Do not install drips where condensate is likely to freeze. Construct drips using a tee with plugged or capped bottom outlet. Drip shall be minimum of 3 pipe diameters long, same size as pipe. Locate drips to permit cleaning and emptying.

H. Install gas line pressure regulator(s) where indicated on drawings.

I. Install a gas isolation valve upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a valve is not required at the second regulator.

J. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free, so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

K. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices

L. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve

M. Install pressure gage upstream and downstream from each line pressure regulator

N. Install vent line from pressure regulators to safe location outdoors. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end

O. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16

P. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code".

Q. Do not use gas piping as a grounding electrode.

R. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.6 REFRIGERANT PIPING SYSTEMS APPLICATION

A. Refrigeration Piping - Above Ground and Under Ground

1. Pipe: Type L or K Seamless Copper, Nitrogenized ACR, ASTM B 88 or ASTM B 280, annealed for 3/8" and smaller, hard drawn for 1/2" and larger. For underground piping 2" and smaller: Type K, annealed, with no fittings.
2. Fittings: ANSI B16.26 cast copper alloy refrigeration type with 45 degree flare or wrought copper ANSI B16.22 socket fittings
3. Joints: brazed, flared (above ground only).

3.7 REFRIGERANT PIPING INSTALLATION REQUIREMENTS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15.

B. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment

C. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lint free cloth through the tubing by means of a wire or an electrician's tape.
2. Draw a clean, lint free cloth saturated with trichloro-ethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
3. Draw a clean, lint free cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
4. Finally, draw a clean, dry, lint free cloth through the tube or pipe.

D. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings

E. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection

F. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation

G. Belowground, install copper tubing in protective conduit. Vent conduit outdoors

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical damage

I. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

J. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

K. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
4. Liquid lines may be installed level.

L. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators

M. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb

N. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves, in liquid line to receiver and on leaving side of liquid solenoid valves.

1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

O. Install strainers immediately ahead of each automatic valve, expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

P. Install strainers in main liquid line where multiple expansion valves with integral strainers are used

Q. Install strainers in suction line of steel pipe

R. Install pressure relief valves on ASME receivers; pipe discharge to outdoors

S. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.

T. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve

U. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down

V. Install receivers, sized to accommodate pump-down charge, on systems 5 tons and larger and on systems with long piping runs

W. Install flexible connectors at the inlet and discharge connection of compressors.

X. Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

Y. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

Z. Install check valves in compressor discharge lines and in condenser liquid lines on multiple condenser systems

AA. Install packed-angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging

BB. Install diaphragm packless or packed-angle valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated

CC. Install a full sized, 3-valve bypass around each drier.

DD. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is specified in Division 26 and 230900. Coordinate electrical requirements and connections.

EE. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.
3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.
4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

FF. Install pressure regulating and relieving valves as required by ASHRAE Standard 15. Pipe pressure relief valve discharge to safe location outdoors

GG. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

HH. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

II. Charge system using the following procedure:

1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psi.
6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

JJ. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

KK. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
3. United States Environmental Protection Agency (US EPA) requirements of Section 808 (Prohibition of Venting and Regulation of CFC) and applicable State and local regulations of authorities having jurisdiction.

LL. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations of authorities

3.8 UNDERGROUND PIPING INSTALLATION REQUIREMENTS

A. Piping below grade intersecting tunnel walls, basement walls, or penetrating floors, shall be run through a sleeve seal system.

1. Size sleeves and select sleeve seal links per sleeve seal manufacturer’s recommendations.
2. Install sleeves and seals per manufacture’s recommendations. Center sleeve water stops at midpoint of wall/floor thickness. Provide temporary support to avoid sleeve collapse during pours.

B. Record as-built sketches and dimensions prior to backfilling.

3.9 WELDING

A. All welding shall be performed by registered welders qualified to perform welding operations in accordance with the National Certified Pipe Welding Bureau’s procedures and standards, ASME Code Standards and the HPACCNA Standard Manual of Welding.

B. Submit a certified copy of “Record of Pipefitter Welder Performance Qualification Test” of any employees who will be doing welding on this project.

C. No welding to building work shall be allowed without approval of Engineer.

D. Except where prohibited by the Reference Standards, code, or ordinance, Black steel piping larger than 6 inch diameter may be welded with chill rings.

E. Mitered turns will not be allowed. Turns shall be made with factory-made ASME B16.9 long radius wrought steel buttwelding fittings.

F. Except where prohibited by the Reference Standards, code, or ordinance, branch take-offs with manufactured formed nipples will be permitted provided nipple size is at least two pipe sizes smaller than the main size. Formed nipples shall be Bonney Forge “Weldolets”, “Threadolets”, “Sockolets”. In all other cases, use factory-made ASME B16.9 wrought steel buttwelding tee fittings.

G. Shop welded pipe assemblies shall have all welds plainly stamped by the welding operator for inspection by the Engineer before installation.

3.10 PROTECTION AGAINST FREEZING

A. At any time that any of the piping is full of water for testing purposes or otherwise prior to actual heated operation, the system shall be protected against freezing by the introduction of pre-mixed propylene glycol type anti-freeze which will be flushed out before acceptance. Provision for introducing anti-freeze shall be made by means of valved connections to the system in an acceptable manner.

3.11 INSTALLATION OF PIPE HANGERS AND SUPPORTS

A. Arrange pipe hangers and supports to permit proper pitch of piping, free to move with pipe expansion, installed at proper intervals to prevent sagging and attached to building construction through approved means. Hangers shall be located near or at changes in piping direction and concentrated loads. Valves, strainers, in line pumps and other heavy equipment shall be supported independent of the pipes. After systems have been installed and filled, adjust hangers and supports to evenly distribute weight, and maintain proper pitch.

B. Vertical Piping: When support locations are not indicated on the drawings, support piping at every floor level.

C. Horizontal Piping Hanger Spacing: Space hangers in compliance with applicable codes, or per MSS SP-89, which ever results in shortest spacing.

D. For cold piping, install hangers and supports to maintain an effective continuous thermal and vapor barrier between cold piping and hangers and supports.

E. Plastic Piping: Hang and support in compliance with manufacturer’s recommendations. At hangers and supports, including channel supports, install to prevent plastic pipe contact with metal (exception: angle iron may be used for continuous support, provided all sharp edges are removed). Anchor piping only where required for expansion loops or to protect against pressure surges, etc. Compression style clamps/supports shall not be used. Use plastic pipe sleeves or equivalent as guides at all other locations, to allow longitudinal thermal expansion and to prevent lateral pipe movement. Compression style riser clamps shall not be used, use other support methods such a supporting at fitting shoulders. Support valves and other significant weight components independent of pipe. Space hangers no farther than manufacturer’s recommendations for the application temperature but in no case farther than recommended for 100 deg. F application temperature. Continuously support all piping 1.5-inch nominal diameter or less (exception: PVC pipe connected to sump pumps). Provide thrust restraints where piping is subject to cyclic pressure surges, e.g. on/off pump applications.

3.12 INSTALLATION OF PIPE SLEEVES

A. Install pipe sleeves where piping passes through building construction including all walls, floors and ceilings.

B. For new wall construction, promptly and accurately locate and securely set sleeves in forms before concrete is poured. For masonry construction, set the sleeves over the piping for Masonry Contractor to build around.

3.13 INSTALLATION OF STRAINERS

A. Provide Y-strainers in steam, condensate, or water piping preceding control valves, traps, pumps, pressure regulating valves and elsewhere as shown on drawings.

B. Install strainer elements prior to flushing piping. Remove, clean and reinstall after flushing.

3.14 TRENCHING AND BACKFILLING

A. All trenching and backfilling required for the proper installation of the work shall be done as prescribed in other Divisions.

B. Excavate trenches so that pipe can be installed at proper depth. Lay pipe on a firm bed bearing its full length except at the bell. Where sewers are installed in backfilled areas, provide machine tamping and be responsible for any settling at, or rupture to the sewer work. Keep trenches water free and as dry as possible during bedding, laying and jointing. After the joints are made, place sufficient backfill along each side of pipe to offset conditions that might tend to move the pipe off line and grade.

C. Backfill only after pipes have been tested, inspected and approved.

D. Piping encountered in excavating, (if shown on the drawings or not), shall be supported, and protected from damage. If utility lines are encountered, notify the Owner's Representative and do not disturb the lines unless so directed. If existing utility lines are damaged during excavations, immediately repair the lines at no cost to the Owner.

E. Storm and sanitary piping may be installed side by side in same trench. Water piping may be installed in same trench with drainage piping, provided trench is benched so the water pipe may be laid on a shelf of firm earth not less than eighteen inches (18") above top of drain pipe.

F. No excavation for pipe shall be made in filled or disturbed earth until it has been compacted as directed.

G. Restore street pavements, curbs and sidewalks disturbed in the performance of this work. Restore in a manner prescribed by authorities having jurisdiction.

H. Where mains are to pass under roadways or in any locations where open ditches are dangerous or undesirable, the work is to be installed by tunneling. In all other locations, excavations shall be done by the open trench method and to the depths and widths as may be necessary. All material excavated shall be deposited on the sides of the trenches and beyond the reach of slides.

I. Supports:

1. Where lines pass under footings for walls or columns, or lower than adjacent footings, backfill trenches with concrete up to the level of the bottom of the footings.
2. Where pipes pass over column footings, or are laid in filled ground, or above the original natural grade, or in soil of insufficient bearing quality, or in other cases where necessary, they shall be supported by creosoted timbers carried by brick piers or piles or other approved supports carried down to firm bearing as approved.

J. Provide shoring, bracing or sheet piling necessary to maintain the banks of the excavations, or tunnels. Take same out as the work is backfilled. Shoring must prevent any movement of the trench banks and strains on the piping and utility lines.

3.15 FLUSHING AND CLEANING OF PIPING

A. Flush the following piping systems:

1. Domestic Cold Water
2. Domestic Hot Water
3. Heating Hot Water Supply and Return

B. Clean the following piping systems:

1. Heating Hot Water Supply and Return

C. Develop plan for flushing and cleaning piping. Submit plan for approval prior to completion of piping. Provide all temporary and permanent piping, equipment, materials necessary to complete flushing and cleaning.

D. Prior to flushing, swab out underground piping to remove all particulate.

E. Prior to flushing, temporarily remove, isolate or bypass dirt sensitive equipment and devices, including the following:

1. Automatic flow control valves
2. Heating and cooling coils
3. Boilers
4. Flow measuring devices

Reinstall after flushing is complete.

F. Prior to flushing, install fine mesh construction strainers at inlet to all equipment. Install fine mesh construction element in permanent strainers. During flushing and cleaning, remove and clean strainers periodically. At completion of final flush, clean permanent strainers, remove construction strainers.

G. Flushing for new piping: Flush all piping with cold water (or fire protection system where approved by owner) for a minimum of one hour, until water runs clear. Water supply shall be equivalent to piping to be flushed. Use (2) 2-1/2” fire hose connections for piping 3” and larger. Drain all low points.

H. Chemical Cleaning for new and existing hydronic piping: Where flushing could not be completed at 6 feet per second, or where chemical cleaning is required for new and existing piping, circulate flush water and clean strainers prior to installing cleaning chemicals. Provide cleaning chemicals, under the direction of the owner’s chemical supplier. Following flushing, install cleaning chemicals and circulate through the entire system for a minimum of one hour, or as directed by chemical supplier. Take water sample for owner’s use. Drain system, including all low points. Flush, drain and fill system, circulate for one hour, sample for owner’s use. Drain, flush, fill, circulate and sample until system is free of cleaning chemicals, as indicated by owner’s analysis of samples.

1. Estimated system volume for Hot Water Heating System:

3.16 PIPING SYSTEM PRESSURE TESTING

A. General:

1. Test new systems only, from point of connection to the existing systems. Perform initial tests and correct deficiencies prior to requesting acceptance test.
2. Perform acceptance pressure tests in the presence of the authorities having jurisdiction. Acceptance tests must be satisfactorily completed before piping surfaces are concealed.
3. Pneumatic tests shall be conducted using dry, oil free compressed air, carbon dioxide or nitrogen. Evacuate personnel not directly involved in testing prior to performing pneumatic testing. Perform

testing in two stages, initial and acceptance. Conduct initial testing at 5 PSI or less. Swab joints with a commercial leak detector. Repair deficiencies prior to testing at higher pressures. Under no circumstances shall plastic piping of any type be pneumatically tested, including pre-acceptance tests.

4. Components shall be removed or isolated during testing if damage may occur due to test pressure and/or test media.
5. Existing steam and hot water piping connected to piping to be tested shall be shutoff, drained and cooled before testing.

B. Acceptance Pressure Testing:

1. Perform acceptance testing at 1.5 times the maximum system design pressure but not less than 100 psig or to the satisfaction of the authority having jurisdiction.
2. Remake leaking gasket joints with new flange bolting. Where welded joints fail, submit proposed method of repair for approval by the Owner's representative and authorities having jurisdiction.
3. For each system tested, provide a certificate testifying that the system was satisfactorily tested and passed, using owner furnished forms.

3.17 FLUSHING, DISINFECTING, AND TESTING DOMESTIC WATER PIPING

A. Flush, disinfect and test domestic water piping as follows:

1. Prior to disinfection, flush all domestic water piping as described under Flushing and Cleaning of Piping.
2. Purge and disinfect domestic water piping per plumbing code and local municipality requirements. Do not use excessive amounts of disinfectant, as it may damage piping seals.
3. Submit water samples in sterile bottles to the local municipality. Repeat the procedure if the biological examination made by the local municipality shows evidence of contamination.

B. Prepare reports for all purging and disinfecting activities. Furnish owner final copy of test results for acceptance.

END OF SECTION 20 1100

SECTION 22 1119 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10 foot head of water.
3. Storm Drainage Piping: 10 foot head of water.
4. Force-Main Piping: 100 psig.

1.3 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Backflow preventers and water regulators
2. Balancing valves, water filters, and strainers
3. Thermostatic water mixing valves
4. Garbage disposal
5. Water hammer arresters, air vents, and trap seal primer valves and systems
6. Drain valves, hose bibbs, hydrants, and hose stations
7. Outlet boxes and washer-supply outlets
8. Backwater valves, cleanouts, floor drains, open receptors, trench drains, and roof drains
9. Air-admittance valves, vent caps, vent terminals, and roof flashing assemblies
10. Grease interceptors, grease recovery units, oil interceptors, and solids interceptors
11. Sleeve penetration systems

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Backflow preventers and water regulators
2. Water filters
3. Thermostatic water mixing valves and water tempering valves
4. Trap seal primer valves and systems
5. Hose stations and hydrants
6. Grease interceptors, grease recovery units, oil interceptors, and solids interceptors

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 01 Sections.

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Water Filter Cartridges: Equal to 200 percent of amount installed for each type and size indicated.
2. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 BACKFLOW PREVENTERS

A. Manufacturers:

1. Conbraco Industries, Inc.
2. Mueller Company; Hersey Meters Division
3. Watts Industries, Inc.; Water Products Division
4. Zurn Industries, Inc.; Wilkins Division
5. Febco

B. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.
2. NPS 2-1/2 and Larger: Bronze, cast iron, steel, or stainless steel body with flanged ends.

a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
5. Strainer: On inlet, if indicated.

C. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

D. Hose-Connection Vacuum Breakers: ASSE 1011, nickel-plated, with non-removable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

E. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, suitable for continuous pressure application. Include inlet screen and two independent check valves with intermediate atmospheric vent.

F. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

G. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

H. Antisiphon-Pressure-Type Vacuum Breakers: ASSE 1020, suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

I. Dual-Check-Valve-Type Backflow Preventers: ASSE 1024, suitable for continuous pressure application. Include union inlet and two independent check valves.

J. Hose-Connection Backflow Preventers: ASSE 1052, suitable for at least 3 gpm flow and applications with up to 10 foot head of water back pressure. Include two check valves; intermediate atmospheric vent; and non-removable, ASME B1.20.7, garden-hose threads on outlet.

K. Back-Siphonage Backflow Vacuum Breakers: ASSE 1056, suitable for continuous pressure and backflow applications. Include shutoff valves, check valve, test cocks, and vacuum vent.

2.3 BALANCING VALVES

A. Calibrated Balancing Valves: Adjustable, with two readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.

1. Manufacturers:

a. ITT Industries; Bell & Gossett Division
b. Taco, Inc.
c. Tour & Andersson, Inc.
d. Flow Design, Inc.

2. NPS 2 and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.
3. NPS 2 and Smaller: Bronze, Y-pattern body with adjustment knob and threaded ends.
4. NPS 2-1/2 and Larger: Cast-iron, Y-pattern body with bronze disc and flanged or grooved ends.

2.4 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

1. Manufacturers:

a. MIFAB Manufacturing, Inc.
b. Josam Company
c. Watts Industries, Inc.; Drainage Products Division
d. Watts Industries, Inc.; Water Products Division
e. Zurn Industries, Inc.; Wilkins Division

B. Roof Flashing Assemblies: Manufactured assembly made of 4-lb/sq. ft., 0.0625-inch thick, lead flashing collar and skirt extending at least 10 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.

1. Manufacturers:

a. Acorn Engineering Company; Elmdor/Stoneman Division
b. Other approved

2. Open-Top Vent Cap: Without cap.
3. Low-Silhouette Vent Cap: With vandal-proof vent cap.
4. Extended Vent Cap: With field-installed, vandal-proof vent cap.

C. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting, joined with ASTM C 564, rubber gaskets.

D. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

E. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semi-open top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

F. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

G. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

H. Vent Terminals: Commercially manufactured, shop- or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.

J. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 4 outlet; shop-applied bituminous coating; and inlet size to match downspout.

K. Downspout Boots: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.

2.5 SLEEVE PENETRATION SYSTEMS

A. Manufacturers:

1. ProSet Systems, Inc.
2. Other approved

B. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.

1. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
2. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye-branch stack fitting with neoprene O-ring at base and gray-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.

a. Special Coating: Include corrosion-resistant interior coating on fittings for plastic chemical waste and vent stacks.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 CLEANOUTS

A. Cleanouts: Comply with [ASME A112.36.2M] [ASME A112.3.1] <Insert other>.

1. Application: Floor cleanout and wall cleanout.
2. Products:

a. MIFAB Manufacturing, Inc., model C1220

b. Josam Company
c. Smith, Jay R. Manufacturing Company
d. Tyler Pipe, Wade Division
e. Watts Industries, Inc., Drainage Products Division
f. Zurn Industries, Inc., Specification Drainage Operation, model Z1400

3. Body or Ferrule Material: Cast iron.
4. Clamping Device: Required.
5. Outlet Connection: Threaded.
6. Closure: Brass plug with straight threads and gasket.
7. Adjustable Housing Material: Set-screws or other device.
8. Frame and Cover Material and Finish: Stainless steel Z1469.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Heavy duty.

2.8 FLOOR DRAINS (REFER TO DRAWING FOR OUTLET SIZE(S))

A. Floor Drains: Comply with ASME A112.21.1M.

1. Application: Type FD-1.
2. Products:

a. Smith, Jay R. Manufacturing Company
b. Zurn Industries, Inc., model ZN-415-SPY
c. Tyler Pipe, Wade Division
d. Josam Company
e. MIFAB Manufacturing, Inc.

3. Body Material: Gray iron.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Exposed Surfaces and Interior Lining: Not required.
8. Sediment Bucket: Required.
9. Top or Strainer Material: Polished nickel bronze.
10. Top of Body and Strainer Finish: Polished nickel bronze.
11. Top Shape: Square.
12. Dimensions of Top or Strainer: 6 x 6 inch.
13. Top Loading Classification: Medium Duty.
14. Funnel: Not required.
15. Inlet Fitting: Not required.
16. Trap Material: Cast iron.
17. Trap Pattern: Deep-seal P-trap.
18. Trap Features: 1/2" trap seal primer valve drain connection.

2.9 ROOF DRAINS

A. Roof Drains: Comply with ASME A112.21.2M or ASME A112.3.1.

1. Application: Type RS-1.
2. Products:

a. Josam Company
b. Smith, Jay R. Manufacturing Company
c. Zurn Industries, Inc.
d. MIFAB Manufacturing, Inc., model R1300T

3. Body Material: Cast iron.
4. Dimensions of Body: 6-3/8” x 6-3/8” x 2-3/4”.
5. Combination Flashing Gravel Stop: Required.
6. Outlet: Side.
7. Dome Material: Cast iron.
8. Underdeck Clamp: Required.

2.10 DOWNSPOUT NOZZLE

A. Downspout nozzle/cover, round fabricated stainless steel frame with secured perforated stainless steel hinged strainer.

1. Application: Type DN-1
2. Products:

a. MIFAB Manufacturing, Inc.,
b. Smith, Jay R. Manufacturing Company
c. Tyler Pipe, Wade Division
d. Zurn, model Z199-DC
e. Josam Company

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 22 0510 "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install garbage disposal per manufacturer’s recommendations. Coordinate power receptacle location with the electrical contractor

D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

F. Install draining-type ground hydrants with 1 cu. yd. of crushed gravel around drain hole.

1. Set ground hydrants with box flush with grade.
2. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.

G. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

H. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

I. Install expansion joints on vertical risers, stacks, and conductors if indicated.

J. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

K. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.

L. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

M. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

N. Install vent-flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

P. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

Q. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished floor, unless otherwise indicated.
2. Provide rebar rods for setting drains.
3. Provide temporary wood spacer to protect drain from debris and support drain sidewall from wrapping during pouring of concrete surround.
4. Bolt grate to drain body using manufacturers supplied vandal resistant grate lockdown assembly.
5. Concrete to be provided by concrete contractor. Mechanical contractor shall be present during pour to insure proper installation.

R. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

S. Install interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
5. Coordinate oil-interceptor storage tank and gravity drain with Section 02554 "Fuel-Oil Distribution."

T. Install grease recovery units on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction.

1. Install control panel adjacent to unit, unless otherwise indicated.

U. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

V. Fasten recessed-type plumbing specialties to reinforcement built into walls.

W. Install wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.

X. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 15 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.

Y. Install air vents at piping high points. Include ball valve in inlet.

Z. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

AA. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 22 Sections.

D. Ground equipment.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

G. Interceptor Connections: Connect piping, flow-control fittings, and accessories.

1. Grease Interceptors: Connect inlet and outlet to unit, and flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic draw off-type unit.
2. Grease Recovery Units: Connect inlet, outlet, and vent piping; controls; electric power; and factory-furnished accessories to unit.
3. Oil Interceptors: Connect inlet, outlet, vent, and gravity draw off piping to unit; flow-control fitting and vent to unit inlet piping; and gravity draw off and suction piping to oil storage tank.
4. Solids Interceptors: Connect inlet and outlet.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Sections

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 CASEWORK

A. Install supply, drainage and vent, piping to and within the casework and hoods. Provide drops to casework and hoods and including final connection to the building service rough-in connection. This includes such items as gas, water or other supplies.

B. Plumbing equipment supports required with the casework shall be supplied and installed as part of the casework.

C. Sinks and fixtures that are not an integral part of the countertop such as epoxy or stainless steel sinks in chemical resistant counter tops shall be set as follows:

1. Stainless steel sinks complete as part of the Work under this Section.
2. Cutouts required for sinks, pedestal, faucets, service fixtures mounted on casework or countertops shall be made as part of the casework in the shop or field for use by the Contractor.

3.5 HANDICAPPED PLUMBING FIXTURE INSTALLATION

A. Installation of handicapped plumbing fixture must comply with Michigan Department of Labor - Barrier Free Design Rules (latest edition). Quantity and mounting heights of water closets, urinals, lavatories and drinking fountains must comply with rules in effect when project is being engineered.

3.6 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate on or near each backflow preventer.

1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
2. Refer to Section 15075 “Mechanical Identification" for nameplates and signs.

3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1119

SECTION 22 4000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, showerheads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.3 SUBMITTALS

A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"**;** Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Plastic Mop-Service Basins: ANSI Z124.6.
4. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water Closet, Flushometer: ASSE 1037, ANSI/ASME 112.19.6.
7. Urinal Flushometer: ASSE 1037, ANSI/ASME 112.19.6.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucet Hose: ASTM D 3901.
5. Faucets: ASME A112.18.1M.
6. Hose-Connection Vacuum Breakers: ASSE 1011.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
9. NSF Materials: NSF 61.
10. Pipe Threads: ASME B1.20.1.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Supply and Drain Fittings: ASME A112.18.1M.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Hose-Coupling Threads: ASME B1.20.7.
3. Off-Floor Fixture Supports: ASME A112.6.1M.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Toilet Seats: ANSI Z124.5.
6. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Products," and "Manufacturers" introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified in other Part 2 articles.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified in other Part 2 articles.

2.2 FIXTURE SUPPORTS

A. Wall Hung Lavatory Support, Type II, lavatory carrier with concealed arms and tie rod.

1. Manufacturers:

a. Zurn
b. Josam
c. Tyler Pipe, Wade Division
d. J. R. Smith
e. MI-Fab

2. Accessible Fixture Support: Include rectangular steel uprights.

2.3 WATER TEMPERING VALVES

A. Manufacturers:

1. Sparco, Inc.
2. Watts Industries, Inc.; Water Products Division
3. Conbraco Industries, Apollo Division 34D
4. Armstrong Rada
5. Wilkins
6. Symmons

B. General: Manually adjustable, thermostatically controlled water tempering valve; bronze body; and adjustable temperature setting ASSE1070.

C. System Water Tempering Valves: Piston or discs controlling both hot- and cold-water flow, capable of limited anti-scald protection. Include threaded inlets and outlet.

1. Finish: Rough bronze.

D. Limited-Volume, Water Tempering Valves: Solder-joint inlets and NPS 3/4 maximum outlet.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guard, Barrier Free/BF PSG-1: Manufactured, plastic covering for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements and ASTM E84.

1. Manufacturers:

a. Plumberex Pro-2000 Series
b. True Bro Lav-Guard
c. Sanitary Dash
d. Skal-Gard
e. Just Manufacturing Company, model J-ADA-125/150

2.5 LAVATORY FAUCETS

A. Lavatory Faucet, LF-1: Single lever with hot and cold water indicators. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Manufacturers:

   a. Delta, Series 2175 Colony Soft

2. Maximum Flow Rate: 1.2 gpm, unless otherwise indicated.
3. Body Material: Copper or brass underbody with brass cover plates.
4. Finish: Polished chrome plate.
5. Type: Single-control mixing.
6. Centers: 4 inches.
7. Mounting: Deck, exposed.
8. Handle(s): Lever.
9. Spout: Rigid.
10. Spout Outlet: Aerator.

2.6 LAVATORIES

A. Lavatories, LAV-1: Wall hanging, vitreous-china fixture. Fixture shall be installed to comply with all ADA requirements.

1. Manufacturers:

   a. Kohler Company
   b. American Standard, Inc. “Lucerne”, model 0355.012
   c. Crane Plumbing/Fiat Products
   d. Sloan

2. Type: With back.
3. Size: 21 x 18.
4. Faucet Hole Punching: Three, 4-inch centers, hole(s).
5. Faucet Hole Location: Top.
6. Color: White.
7. Faucet**:** LF-1.
8. Supplies: NPS 3/8 chrome-plated copper with stops.
9. Drain: Fixed grid strainer.
10. Drain Piping: Offset NPS 1-1/4 by NPS 1-1/2 chrome-plated cast-brass trap; 0.032-inch-thick tubular brass waste to wall; and wall escutcheon.
11. Protective Shielding Guard on Water and Drain Line: PSG-1.
12. Fixture Support: Concealed arms.
13. Mixing Valve: Water mixing valve.

2.7 SINK FAUCETS

A. Sink Faucet, SF-1: 12” Gooseneck, two lever faucet with hot and cold levers.

1. Manufacturer:

   a. Delta
   b. American Standard
   c. Eljer
   d. Just Manufacturering Company, model J-1174-KS
   e. Moen

2. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
3. Body Material: Copper or brass underbody with brass cover plates.
4. Finish: Polished chrome plate.
5. Type: gooseneck
6. Centers: 8 inches.
7. Mounting: Deck, exposed.
8. Handle(s): Two.
9. Spout: Rigid.
10. Spout Outlet: Aerator.

2.8 SINKS

A. Sink, SK-1: Clinic 405, single bowl undermount, self-rimming, seamless, “satin” finish, AISI Type 304 stainless steel, 18 gage. Coat underside with sound deadening non-marring mastic.

1. Manufacturers:

   a. Elkay
   b. Just Manufacturing Company, model UO1FADA1521A45-J
   c. Kohler
   d. Dayton Products, Inc.

2. Type: Self-rimming.
3. Overall Rectangular Size: 20 x 15 overall, 20 x 15 x 4-1/2 deep inside bowl.
4. Faucet Hole Punching SF-1: Single hole.
5. Faucet Hole Punching SF-2 (bubble): Single hole.
6. Faucets: SF-1.
7. Supplies: NPS 3/8 chrome-plated brass with stops.
8. Drain: Fixed grid strainer.
9. Provide ASSE 1070 mixing valve.

B. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated cast-brass trap; NPS 1-1/2, 0.045-inch thick tubular brass waste to wall; and wall escutcheon.

C. Sink, SK-2: Single bowl, undermount, self-rimming, “satin” finish, AISI Type 304 stainless steel, 18 gage. Coat underside with sound deadening non-marring mastic.

1. Manufacturers:

   a. Kohler
   b. Elkay
   c. Just Manufacturing Company, model USADA13518A50-J
   d. Crane

2. Type: Self-rimming.
3. Overall Rectangular Size: 14” x 18-1/2” x 4-5/8” deep inside bowl.
4. Faucet Hole Punching: Three, 4 inch centers, holes.
5. Faucet: SF-1.
6. Supplies: NPS 3/8 chrome-plated brass with stops.
7. Drain: Fixed grid strainer.
8. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated cast-brass trap; NPS 1-1/2, 0.045-inch thick tubular brass waste to wall; and wall escutcheon.
9. Provide ASSE 1070 mixing valve.

2.9 WATER CLOSET FLUSHOMETERS

A. Flushometer, WC-1: Cast-brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.

1. Manufacturers:

   a. Delany
   b. Sloan, model 111-1.6-YG-G
   c. Zurn

2. Internal Design: Diaphragm or piston operation.
3. Style: Exposed.
4. Inlet Size: NPS 1.
5. Trip Mechanism: Oscillating, lever-handle actuator.
6. Consumption: 1.6 gallons/flush.
7. Tailpiece Size: NPS 1-1/4 or 3/4 inch and standard length to top of bowl.

2.10 TOILET SEATS

A. Toilet Seat, TS-1: Solid plastic, with extended back with STA-TITE commercial fastening system.

1. Manufacturers:

   a. Beneke
   b. Church
   c. Bemis
   d. Kohler
   e. Centoco

2. Configuration: Open front without cover.
3. Size: Elongated.
4. Class: Heavy-duty commercial.
5. Hinge Type: CC/SC, self-sustaining, check with STA-TITE commercial fastening system.
6. Color: White.

2.11 WATER CLOSETS

A. Water Closets, WC-1: Floor-mounting, floor-outlet, vitreous china fixture designed for flushometer valve operation. Fixture shall be installed to comply with all ADA requirements.

1. Manufacturers:

   a. American Standard, Inc.
   b. Crane Plumbing/Fiat Products
   c. Kohler Company “Highcliff”, model K-96057
   d. Sloan

2. Style: Close coupled.
3. Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
4. Height: Standard, barrier free accessible.
5. Design Consumption: 1.6 gallons/flush.
6. Color: White.
7. Supply: NPS 1-1/2 chrome plated brass or copper with loose-key stop.
8. Flushometer: WC-1.
9. Toilet Seat: TS-1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

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

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install water-less urinals per manufacturer’s requirements.

C. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

D. Install back-outlet, wall hanging fixtures onto waste fitting seals and attach to supports.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Section 22 0523 "General-Duty Valves" for general-duty valves.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

O. Install disposer in outlet of sinks indicated to have disposer.

P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Section 15050 "Basic Mechanical Materials and Methods" for escutcheons.

Q. Set service basins in leveling bed of cement grout. Refer to Section 22 0510 "Basic Mechanical Materials and Methods" for grout.

R. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 07 Sections for sealant and installation requirements.

3.3 INSTALLATION OF WATER CLOSETS - BARRIER FREE

A. Mounting Heights:

1. Water Closets – Barrier Free: 18" from top of toilet seat to finished floor.

B. Flush Valve: Mount flush valve handle on wide side of stall/room. At every dual flush valve, sign shall be mounted over the center line of the flush valve and screwed to the wall in each corner.

C. Install the electric eye plate, flush with the wall as recommended per the manufactures installation directions. Mount the dual flush sign to the wall utilizing wall anchors and screws.

3.4 INSTALLATION OF LAVATORIES/SINKS - STANDARD AND BARRIER FREE

A. General: Unless otherwise noted on drawings, locate lavatory in compliance with ADA requirements.

B. Countertop: Coordinate with architectural trades.

C. Wall Hung: Conceal lavatory fixture support arms with deep drawn secure escutcheons. Securely bolt and anchor supports to the supporting surfaces.

D. Install a water tempering valve for each lavatory, kitchen hand sink and sink faucet.

3.5 INSTALLATION OF PLUMBING FIXTURES

A. Individual water line branches, waste lines, vents and traps for connection to individual fixtures, fixture fittings and specialties shall be per the following schedule or as indicated on drawings, whichever is greater (sizes are given in inches).

Item	Waste	Vent	Trap	Cold	Hot
Lavatory	1-1/2	1-1/2	1-1/4	1/2	1/2
Sink	1-1/2	1-1/2	1-1/2	1/2	1/2
Janitor/Service Sink	3	1-1/2	3	1/2	1/2
Wall Hydrant (Shower Rooms)	--	--	--	3/4	3/4
Wall Hydrant	--	---	--	3/4	---
Hose Bib	--	---	--	3/4	---

3.6 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.7 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.8 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers. Replace damaged and malfunctioning units.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

3.9 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.10 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4000

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Setting quantitative performance of HVAC equipment.
4. Verifying that automatic control devices are functioning properly.
5. Reporting results of the activities and procedures specified in this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. TDH: Total Dynamic Head

N. AABC: Associated Air Balance Council.

O. AMCA: Air Movement and Control Association.

P. CTI: Cooling Tower Institute.

Q. NEBB: National Environmental Balancing Bureau.

R. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 BALANCING CONTRACTORS

A. Only the following contractors will be allowed to provide air and water testing and balancing.

1. Absolut Balance
2. Air Flow Testing.
3. Ener-Tech Testing.
4. Enviro-Aire/Total Balance, Inc.
5. Hi-Tech Test and Balance
6. International Test and Balance
7. Mechanical Testing Services, Inc.

1.6 QUALITY ASSURANCE

A. Agent Qualifications: Testing, adjusting, and balancing agent shall be certified by either AABC or NEBB.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members,

equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements
    b. Contract Documents examination report
    c. Testing, adjusting, and balancing plan
    d. Work schedule and Project site access requirements
    e. Coordination and cooperation of trades and subcontractors
    f. Coordination of documentation and communication flow

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."

E. Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

F. Testing, Adjusting, and Balancing Reports: Use standard forms from SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing."

G. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Architect.

H. Instrumentation Type, Quantity, and Accuracy: As described in AABC National Standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

I. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.7 PROJECT CONDITIONS

A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.9 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

C. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

D. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

K. Examine strainers for clean screens and proper perforations.

L. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine equipment for installation and for properly operating safety interlocks and controls.

O. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

P. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section.

B. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

C. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems--Testing, Adjusting, and Balancing" and this Section.

D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

E. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for correct fan rotation.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design with the approval of the Architect. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
3. Measure total system airflow. Adjust to within 5 percent of design airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated
9. Check for correct pump rotation.

3.8 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

   c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

4. Prior to verifying final system conditions, determine the system differential-pressure set point.
5. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
6. Mark final settings and verify that all memory stops have been set.
7. Verify final system conditions as follows:

   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.

8. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

3.9 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.

3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.10 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers
2. Motor horsepower rating
3. Motor rpm
4. Efficiency rating if high-efficiency motor
5. Nameplate and measured voltage, each phase
6. Nameplate and measured amperage, each phase
7. Starter thermal-protection-element rating

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.11 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.12 HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.13 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.14 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: 0 to plus 5 percent.
2. Air Outlets and Inlets: Plus 5 to minus 5 percent.
3. Heating-Water Flow Rate: Plus 5 to minus 5 percent.

3.15 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.16 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.17 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves
2. Fan curves
3. Manufacturers' test data
4. Field test reports prepared by system and equipment installers
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page
2. Name and address of testing, adjusting, and balancing Agent
3. Project name
4. Project location
5. Architect's name and address
6. Engineer's name and address
7. Contractor's name and address
8. Report date
9. Signature of testing, adjusting, and balancing Agent who certifies the report
10. Summary of contents, including the following:

    a. Design versus final performance
    b. Notable characteristics of systems
    c. Description of system operation sequence if it varies from the Contract Documents

11. Nomenclature sheets for each item of equipment
12. Data for terminal units, including manufacturer, type size, and fittings
13. Notes to explain why certain final data in the body of reports vary from design values
14. Test conditions for fans and pump performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers
    b. Conditions of filters
    c. Cooling coil, wet- and dry-bulb conditions
    d. Face and bypass damper settings at coils
    e. Fan drive settings, including settings and percentage of maximum pitch diameter
    f. Inlet vane settings for variable-air-volume systems
    g. Settings for supply-air, static-pressure controller
    h. Other system operating conditions that affect performance

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows
2. Water and steam flow rates
3. Duct, outlet, and inlet sizes
4. Pipe and valve sizes and locations
5. Terminal units
6. Balancing stations

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

    a. Unit identification
    b. Location
    c. Make and type
    d. Model number and unit size
    e. Manufacturer's serial number
    f. Unit arrangement and class
    g. Discharge arrangement
    h. Sheave make, size in inches, and bore
    i. Sheave dimensions, center-to-center and amount of adjustments in inches
    j. Number of belts, make, and size
    k. Number of filters, type, and size

2. Motor Data: Include the following:

   a. Make and frame type and size
   b. Horsepower and rpm
   c. Volts, phase, and hertz
   d. Full-load amperage and service factor
   e. Sheave make, size in inches, and bore
   f. Sheave dimensions, center-to-center and amount of adjustments in inches

3. Test Data: Include design and actual values for the following:

   a. Total airflow rate in cfm
   b. Total system static pressure in inches wg
   c. Fan rpm
   d. Discharge static pressure in inches wg
   e. Filter static-pressure differential in inches wg
   f. Preheat coil static-pressure differential in inches wg
   g. Cooling coil static-pressure differential in inches wg
   h. Outside airflow in cfm
   i. Return airflow in cfm
   j. Outside-air damper position
   k. Return-air damper position

G. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:

   a. System identification
   b. Location
   c. Coil type
   d. Number of rows
   e. Fin spacing in fins per inch
   f. Make and model number
   g. Face area in sq. ft.
   h. Tube size in NPS
   i. Tube and fin materials
   j. Circuiting arrangement

2. Test Data: Include design and actual values for the following:

   a. Airflow rate in cfm
   b. Average face velocity in fpm
   c. Air pressure drop in inches wg
   d. Outside-air, wet- and dry-bulb temperatures in deg F
   e. Return-air, wet- and dry-bulb temperatures in deg F
   f. Entering-air, wet- and dry-bulb temperatures in deg F
   g. Leaving-air, wet- and dry-bulb temperatures in deg F

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to the manufacturer's factory startup equipment reports, include the following:

1. Unit Data: Include the following:

   a. System identification
   b. Location
   c. Make and type
   d. Model number and unit size
   e. Manufacturer's serial number

f. Fuel type in input data
g. Output capacity in Btuh
h. Ignition type
i. Burner-control types
j. Motor horsepower and rpm
k. Motor volts, phase, and hertz
l. Motor full-load amperage and service factor
m. Sheave make, size in inches, and bore
n. Sheave dimensions, center-to-center and amount of adjustments in inches

2. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm
b. Entering-air temperature in deg F
c. Leaving-air temperature in deg F
d. Air temperature differential in deg F
e. Entering-air static pressure in inches wg
f. Leaving-air static pressure in inches wg
g. Air static-pressure differential in inches wg
h. Low-fire fuel input in Btuh
i. High-fire fuel input in Btuh
j. Manifold pressure in psig
k. High-temperature-limit setting in deg F
l. Operating set point in Btuh
m. Motor voltage at each connection
n. Motor amperage for each phase
o. Heating value of fuel in Btuh

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification
b. Location
c. Make and type
d. Model number and size
e. Manufacturer's serial number
f. Arrangement and class
g. Sheave make, size in inches, and bore
h. Sheave dimensions, center-to-center and amount of adjustments in inches

2. Motor Data: Include the following:

a. Make and frame type and size
b. Horsepower and rpm
c. Volts, phase, and hertz
d. Full-load amperage and service factor
e. Sheave make, size in inches, and bore
f. Sheave dimensions, center-to-center and amount of adjustments in inches
g. Number of belts, make, and size

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm
b. Total system static pressure in inches wg
c. Fan rpm
d. Discharge static pressure in inches wg
e. Suction static pressure in inches wg

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number
b. Location and zone
c. Traverse air temperature in deg F
d. Duct static pressure in inches wg
e. Duct size in inches
f. Duct area in sq. ft.
g. Design airflow rate in cfm
h. Design velocity in fpm
i. Actual airflow rate in cfm
j. Actual average velocity in fpm
k. Barometric pressure in psig

K. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification
b. Location and zone
c. Test apparatus used
d. Area served
e. Air-terminal-device make
f. Air-terminal-device number from system diagram
g. Air-terminal-device type and model number
h. Air-terminal-device size
i. Air-terminal-device effective area in sq. ft.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm
b. Air velocity in fpm
c. Preliminary airflow rate as needed in cfm
d. Preliminary velocity as needed in fpm
e. Final airflow rate in cfm
f. Final velocity in fpm
g. Space temperature in deg F

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification
b. Location and zone
c. Room or riser served
d. Coil make and size
e. Flowmeter type

2. Test Data: Include design and actual values for the following:

   a. Airflow rate in cfm
   b. Entering-water temperature in deg F
   c. Leaving-water temperature in deg F
   d. Water pressure drop in feet of head or psig
   e. Entering-air temperature in deg F
   f. Leaving-air temperature in deg F

M. Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.

1. Unit Data: Include the following:

   a. Unit identification
   b. Location
   c. Service
   d. Make and size
   e. Model and serial numbers
   f. Water flow rate in gpm
   g. Water pressure differential in feet of head or psig
   h. Required net positive suction head in feet of head or psig
   i. Pump rpm
   j. Impeller diameter in inches
   k. Motor make and frame size
   l. Motor horsepower and rpm
   m. Voltage at each connection
   n. Amperage for each phase
   o. Full-load amperage and service factor
   p. Seal type

2. Test Data: Include design and actual values for the following:

   a. Static head in feet of head or psig
   b. Pump shutoff pressure in feet of head or psig
   c. Actual impeller size in inches
   d. Full-open flow rate in gpm
   e. Full-open pressure in feet of head or psig
   f. Final discharge pressure in feet of head or psig
   g. Final suction pressure in feet of head or psig
   h. Final total pressure in feet of head or psig
   i. Final water flow rate in gpm
   j. Voltage at each connection
   k. Amperage for each phase

N. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

   a. Instrument type and make
   b. Serial number
   c. Application
   d. Dates of use
   e. Dates of calibration

3.19 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect and/or Owner.

B. Architect/Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 0593

SECTION 23 0900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Related Sections:

1. Division 20: Common Mechanical Requirements
2. Division 22: Plumbing
3. Division 23: Heating, Ventilating and Air-Conditioning (HVAC)
4. Division 26: Electrical
5. Division 28: Electronic Safety and Security

1.2 SUMMARY

A. This Section Includes:

1. Building Automation System (BAS), including controls for mechanical equipment to control temperature, humidity, ventilation, pressure, and other functions as indicated.
2. BAS Operator Interface System (OIS) including operator interface for monitoring and control of connected systems and equipment.
3. Refer to Drawings for Sequence of Operations and additional requirements related to this section.

B. Scope of Work:

1. The Mechanical Systems Controls Contractor (MSCC) shall provide and install all controls, sensors, wiring, control valves, dampers, electrical, and accessories as indicated and as necessary for a complete mechanical controls solution.
2. The MSCC shall complete systems integration of all new custom and packaged mechanical controls devices, and additional devices indicated in the project Drawings and Specifications, into the existing Owner centralized BAS Operator Interface System (OIS) for the remote monitoring and control of the BAS including but not limited to BAS system point monitoring, developed system graphics, point trends, equipment schedules, and system alarm annunciation.
3. The MSCC shall complete field installation of devices, wiring, and integration into the central OIS as indicated in project Drawings and Specifications for Units provided with packaged controls by the unit manufacturer.

1.3 DEFINITIONS

A. AE: Architect/Engineer.

B. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

C. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

D. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.

3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. B-AWS: BACnet Advanced Operator Workstation
6. B-OWS: BACnet Operator Workstation
7. B-OD: BACnet Operator Display
8. B-BC: BACnet Building Controller
9. B-AAC: BACnet Advanced Application Controller
10. B-ASC: BACnet Application Specific Controller
11. B-LD: BACnet Lighting Device
12. B-SS: BACnet Smart Sensor
13. B-SA: BACnet Smart Actuator
14. B-RTR: BACnet Router
15. B-GW: BACnet Gateway
16. B-BBMD: BACnet Broadcast Management Device
17. B-GEN: BACnet General

E. BAS: Building Automation System.

F. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

G. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

H. COV: Changes of value.

I. DDC: Direct Digital Control.

J. EEPROM: Electronically Erasable Programmable Read-Only Memory.

K. EPROM: Erasable Programmable Read-Only Memory.

L. E/P: Voltage to pneumatic.

M. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

N. IP: Internet Protocol.

O. I/P: Current to pneumatic.

P. IT: Information Technology.

Q. LAN: Local Area Network.

R. LCC: Laboratory Controls Contractor.

S. LNS: LonWorks Network Services.

T. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.

2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
13. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

U. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

V. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

W. Modbus TCP/IP: An open protocol for exchange of process data.

X. MSCC: Mechanical Systems Controls Contractor.

Y. MSTP: Master/Slave Token Passing.

Z. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

AA. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

BB. OIS: Operator Interface System.

CC. Peer to Peer: Networking architecture that treats all network stations as equal partners.

DD. PICS: BACnet Protocol Implementation Conformance Statement.

EE. RAM: Random access memory.

FF. RF: Radio frequency.

GG. Router: Device connecting two or more networks at network layer.

HH. Server: Computer used to maintain system configuration, historical and programming database.

II. SI: Systems Integrator.

JJ. TCP/IP: Transport control protocol/Internet protocol.

KK. UC: Unitary Controller.

LL. UPS: Uninterruptible power supply.

MM. USB: Universal Serial Bus.

NN. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

OO. VAV: Variable air volume.

1.4 SYSTEM DESCRIPTION

A. Demolition Work: The MSCC shall visit the job site prior to, and during, the demolition phase to clearly identify and protect control tubes, wires, and devices necessary to keep the remaining systems active during the project phasing. Post construction demolition relative to control infrastructure shall be coordinated by this contractor with the construction manager and demolition contractor. All obsolete control equipment shall be removed from the site, unless otherwise noted on the drawings. The MSCC shall be responsible to repair visible architectural finishes surrounding demolished materials as necessary to match existing. The MSCC shall be responsible to ensure that any demolition activities involving existing site Controls Systems, field device networks, or Operator Interface Systems do not impact or alter the operation or performance of any existing site Systems or Equipment intended to remain.

B. New Work: Provide all items, articles, materials, operations, or methods listed, mentioned, or scheduled on drawings and/or herein, including all labor, materials, equipment, and incidentals necessary and required to complete the installation of the controls for equipment as indicated on the drawings and herein described.

C. Provide a Building Automation System (BAS) incorporating Direct Digital Control (DDC), equipment monitoring, and control consisting of microcomputer based DCC Panels interfacing directly with sensors, actuators and environmental delivery systems (i.e., HVAC units, boilers, etc.); electric controls and mechanical devices for all items indicated on drawings, a primary communication network to allow data exchange from DDC panel to DDC panel; microcomputer based Unitary DDC Controllers (UCs) interfacing with sensors, actuators, and terminal equipment control devices; and a secondary communication network interfacing UCs to DDC panel network devices. The system shall be based on industry standard open protocols.

1. The Mechanical Systems Controls Contractor (MSCC) shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for central plant engineering, building ventilation equipment, supplemental heating and cooling equipment and terminal units.
2. Provide networking to new DDC equipment using communication standards. System shall be capable of BACnet communication according to the most recent version of ASHRAE standard ANSI/ASHRAE 135 for interoperability with smart equipment and for the main IP communication trunk to the BAS server. The system shall not be limited to only standard protocols but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
3. Provide standalone controls where called for on the drawings or sequences.

4. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.
5. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers and all input/output devices. Items of work included are as follows:

    a. Provide a submittal that meets the requirements below for approval.
    b. Coordinate installation schedule with the mechanical contractor and general contractor.
    c. Provide installation of all panels and devices unless otherwise stated.
    d. Provide power for panels and control devices.
    e. Provide 120VAC circuits, wiring, and raceway as necessary to power all controllers and controls components. Power shall be provided from available circuit(s) within the nearest available electric distribution panel(s).
    f. Provide all low voltage control wiring and raceway for the DDC system.
    g. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
    h. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
    i. Participate in commissioning for all equipment that is integrated into the BAS (refer to commissioning sections of the equipment or systems in other parts of this specification).
    j. Provide testing, demonstration and training as specified below.

D. Provide on-site supervision, calibration, and checkout of the control systems.

E. It is the responsibility of the Contractor to review the Drawings and specifications of all other trades concerning this project to determine what equipment is to be furnished and/or installed and/or connected by the Contractor in addition to that equipment called for in the project Specifications and Drawings.

F. Provide shop drawings as specified herein.

G. Provide guarantee as specified herein.

H. Provide classroom training instructions to Owner's operating and maintenance personnel as specified herein.

1.5 SUBMITTALS

A. Qualification Data:

1. Systems Provider Qualification Data:

    a. Resume of project manager assigned to Project.
    b. Resumes of application engineering staff and technicians assigned to Project.
    c. Descriptions of past projects completed, demonstrating required experience with projects of similar scope, size, and complexity.

2. Manufacturer's qualification data.

B. Product Data:

1. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
2. Include ASHRAE BACnet Conformance documents for each DDC system component (panel, zone controller, field devices, and operator workstation) proposed including the following:

    a. PICS Document

b. BACnet Testing Laboratories Product Listing
c. BACnet Testing Laboratories Conformance Certificate

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
3. Details of control panel faces, including controls, instruments, and labeling.
4. Written description of sequence of operation.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including leakage and flow characteristics.
7. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
8. Listing of connected data points, including connected control unit and input device. Input/output point summary with recommended set points.
9. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
10. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
11. Bill of materials to identify each control device.
12. A complete set of shop drawings shall be properly identified with the Engineer's project number and title. Shop drawings shall be 11" x 17" size (minimum).
13. Show interface with Work under other Contracts. Clearly illustrate, identify and define all components, assemblies, subsystems, and systems; relationship, interface, function, action, setting accuracy, range, sequence of operation, normal and abnormal conditions.

D. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

E. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 01.

F. Warranties: Special warranties specified in this Section.

G. No work shall be executed until the final submittals are approved by the project AE.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise and submit Shop Drawings to reflect actual installation and operating sequences.

1.6 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details prior to installation.

B. Coordinate with the Mechanical Contractor for equipment provided with packaged controls including but not limited to field installation, wiring, and configuration of any supporting devices as necessary, and to complete integration to packaged unit controllers where indicated.

C. Coordinate with any auxiliary systems contractors to complete integration of auxiliary systems (i.e. Laboratory Controls, Lighting Controls, Power Monitoring, Security, etc.) into the central site Operator Interface System.

D. Coordinate locations and requirements for IT Data connections with the Electrical/Technology Contractor.

1.7 ACCEPTABLE MECHANICAL SYSTEMS CONTROLS CONTRACTORS

A. Acceptable Mechanical Systems Controls Contractors, subject to compliance with requirements of this specification and the project Drawings. Substitutions are not acceptable:

1. Control Net LLC

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project, including a minimum of 2 years of documented experience with projects of similar scope and complexity.

B. Manufacturer Qualifications: A company experienced in manufacturing automatic temperature-control systems like those indicated for this Project and with a record of successful in-service performance, including a minimum of 5 years of documented experience.

C. Install all BAS components, devices, and wiring in compliance with NEC and all local electrical codes.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

F. Comply with ASHRAE 135 for DDC system control components.

1.9 DELIVERY, STORAGE AND HANDLING

A. In strict compliance with the manufacturer’s written instructions and recommendations, materials shall be provided to ensure that all equipment and components are completely protected from damage, dirt, or weather during shipping, storage, prior to installation, and after installation for the duration of the construction activities.

B. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 WARRANTY

A. Contractor guarantees that this installation is free from defects and agrees to replace or repair, free of any charge to the satisfaction of the Owner's Representative any part of this installation including all components, parts and assemblies of the System which may fail within a period of one (1) year after final acceptance, provided that such failure is due to defects in the materials or workmanship or due to a failure to follow the specifications and drawings. The Contractor shall file with the Owner all guarantees from the equipment manufacturers and what operating conditions and performance capacities they are based on.

B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers of DDC Controllers and accessories, subject to compliance with requirements of this specification and the project Drawings:

1. Honeywell Spyder

2.2 GENERAL

A. The MSCC shall provide a complete mechanical controls system including but not limited to programming, DDC controllers, software, sensors, transmitters, control valves, dampers, power supplies and wiring, network, gateways, routers, and all other devices required for a complete system.

B. The MSCC shall complete systems integration of all new controls into the existing Owner centralized Tridium/Niagara BAS Operator Interface System (OIS) to facilitate remote monitoring and control of mechanical controls systems including but not limited to developed system graphics, point monitoring, point commanding, point trending, equipment operation schedule management, and system alarm configuration and annunciation. MSCC shall upgrade the existing OIS as necessary to facilitate systems integration.

C. The MSCC shall provide a BACnet IP and/or MSTP field/floor level network or networks and shall connect all field devices to a BACnet B-BC controller or controllers. The B-BC controller(s) shall communicate with the BAS OIS server via the Owner's IP network.

D. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, expansion modules, and operator devices.

E. System network architecture shall be completed such that each BAS controller shall operate independently by performing its own specified control, I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

F. Systems requiring multiple controllers (i.e. large chilled water plants) shall not utilize the Owner IP network for communication between common system controllers.

G. All controllers within a building shall be able to access any data from, or send control commands directly to, any other DDC controller or combination of controllers in the same building without dependence upon a central processing device (peer-to-peer).

H. All connected devices and systems must meet minimum Owner IT security requirements. The MSCC is responsible for remediation of any network security vulnerabilities identified by the Owner's IT department during the construction period and up to 1 year after project substantial completion.

2.3 OPERATOR INTERFACE SYSTEM

A. General:

1. The MSCC shall complete systems integration of all new controls into the existing Owner centralized Tridium/Niagara BAS Operator Interface System (OIS) to facilitate remote monitoring and control of mechanical controls systems including but not limited to developed system graphics, point monitoring, point commanding, point trending, equipment operation schedule management, and system alarm configuration and annunciation. MSCC shall upgrade the existing OIS as necessary to facilitate systems integration.
2. The MSCC shall review site network security requirements with the Owner's designated IT Support contact person and shall provide network security software and hardware components as necessary to meet site security requirements. Additionally, the MSCC shall provide network security software and hardware components as necessary to properly secure the BAS network and devices from other LAN connected devices.

B. Systems Integration: The MSCC shall complete integration of all new mechanical controls devices and devices indicated in the project Drawings and Specifications into the common central OIS, including but not limited to Mechanical Systems Controls, Laboratory Controls, Lighting Controls, Power Monitoring, Fire Alarm System, and Security Systems.

1. Points: Available points from connected field devices shall be integrated into the central OIS as follows:

   a. Mechanical Infrastructure Systems: Integrate all available points
   b. Mechanical Terminal Equipment and Packaged Equipment Controllers: Integrate all physical device input and output points, as well as system virtual setpoints and other control points as necessary to enable appropriate equipment operation and monitoring by central system operators. All available system points are not required for integration.

2. Graphics: Graphics shall be created and organized to allow a system operator to fully navigate system graphics via graphic buttons. Graphics shall include the following:

   a. Homepage including a map view of and click link buttons to all Owner sites connected to OIS.
   b. Homepage for each building including building photograph and click button links to all connected central building equipment, or equipment summary pages, and links to building floorplan graphics.
   c. Graphics shall include uploaded building key plan style floorplans for all building floors including room numbers. Floorplan graphics shall include key information (i.e.. room temperature) from and click button links to terminal equipment associated with each room.
   d. Do not display extraneous points (not pertinent) on viewable graphics or display screens.
   e. Written sequence of operation shall be included and shall be click linked to the associated equipment or system graphic for reference.
   f. For each building, include a comprehensive network architecture riser diagram including all connected devices for the site and showing connection to the central OIS server. Diagram shall indicate the active connectivity status of each connected device.
   g. All control contractor as built documents and product cut sheets shall be converted into .pdf files and made available through a link on the OIS graphics.
   h. Data to be displayed within a unique graphic shall be assignable regardless of physical hardware address, communication channel or point type. Graphics shall be on-line programmable and under password access control. Points shall be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified. Graphics shall also contain calculated or "software" points. Each physical point and each point assigned to a graphic shall be assigned an English descriptor for use in reports.
   i. Points shall be displayed with dynamic data provided by the system with appropriate text descriptor, status or value, and engineering unit. Coloration shall be used to designate alarm states, and status including point connectivity and override status. Coloration shall be variable for each class of points, as chosen by the Owner.
   j. Graphics shall include direct links to applicable system trend reports and views.
   k. An on-line "help" utility shall be provided to facilitate operator training and understanding. The "help" utility shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialogue box.

3. Trends: System point trends shall be configured for connected systems as follows:

   a. Central Mechanical Equipment: Include trending for all main system points such as temperature, pressure, flow, valve command, damper command, setpoints, motor command and status, etc. Trends shall be change of value (COV) based including a maximum 1 hour time interval between recorded point values.
   b. Terminal Mechanical Equipment: Include trending for current room temperature, any unique terminal monitoring points such as carbon monoxide, carbon dioxide, etc., and any other critical terminal monitoring points as necessary.
   c. Auxiliary Systems: Include minimum baseline trending of key system operational and monitoring points.

4. Alarms: Configure system alarms for monitoring of all key operational parameters of all central mechanical systems and auxiliary systems, and terminal equipment monitoring points as necessary. Several examples of required system alarm points are included below:

    a. Fan or pump motor status does not match enable command for 10 seconds
    b. Boiler or chiller status does not match enable command for 10 seconds
    c. Equipment general alarm point has changed state to alarm status
    d. Air Handling Unit freezestat has tripped
    e. Air Handling Unit discharge air temperature is +/-5°F of setpoint during occupied mode
    f. Air Handling Unit end of duct static pressure is +/-0.5" WC of setpoint during occupied mode
    g. Air Handling Unit return air relative humidity is >70%RH during occupied mode
    h. Hydronic system liquid temperature is +/-5°F of setpoint when the system is enabled
    i. Hydronic system pressure is +/-5 psi of setpoint when the system is enabled
    j. Space/room temperature is <50°F or >90°F
    k. Area lighting status does not match enable command for 10 seconds

2.4 DDC CONTROLLERS AND ASSOCIATED COMPONENTS

A. DDC Controllers:

1. All BAS controllers shall use the latest version of ANSI/ASHRAE Standard 135 BACnet standard for communications, have passed BACnet Testing Laboratories (BTL) certification and be listed as compliant with UL916 Standard for Energy Management Equipment. BAS controllers used in smoke control applications must also be listed as compliant with UL864 Standard for Control Units and Accessories for Fire Alarm Systems.
2. All controllers shall be listed by BTL as conforming to the required standard device profile and support all of the minimum required BACnet Interoperability Building Blocks (BIBBs) associated with this device profile.
3. BAS controller types shall be one of three types, a BACnet Building Controller (B-BC), a BACnet Advanced Application Specific Controller (B-AAC) or a BACnet Application Specific Controllers (B-ASC).

    a. Building Controllers (B-BC) shall be used for all major mechanical equipment and/or systems (i.e. chilled water, heating hot water, large AHU's, etc.).
    b. Advanced Application Specific Controllers (B-AAC) shall be used, as an extension of a B-BC's performance and capacity, for control of all medium and small mechanical systems and/or terminal equipment.
    c. Application Specific Controllers (B-ASC) shall only be allowed to be used on terminal equipment including VAV boxes, FCU's, etc.

4. BACnet Building Controller (B-BC):

    a. Provide controllers conforming to the latest version of ANSI/ASHRAE 135 BACnet Building Controller (B-BC) standard device profile and support all of the minimum required BACnet Interoperability Building Blocks (BIBBs) associated with this device profile.
    b. Controllers shall support Internet Protocol (IP) for communications to other BC's and the OIS and MS/TP communication to B-AAC's and B-ASC's.
    c. Controllers shall have a 32 bit processor with an EEPROM, flash driven operating system. They shall be multi-tasking, multi-user, real-time digital control processors and permit I/O expansion for control / monitoring of up to 48 I/O. Controller size shall be sufficient to fully meet the requirements of this specification. Controllers shall be fully programmable while supporting standard energy management functions, including but not limited to:

        1) Alarm detection and reporting
        2) Automatic Daylight Saving Time switchover
        3) Calendar-based scheduling
        4) Closed loop PID control
        5) Duty cycling
        6) Economizer control

7) Equipment scheduling, optimization and sequencing
8) Event scheduling
9) Historical trend collection
10) Holiday scheduling
11) Logical programming
12) Reset schedules
13) Night setback control
14) Peak Demand Limiting (PDL)
15) Start-Stop Time Optimization (SSTO)
16) Temperature-compensated duty cycling
17) Temporary schedule override

d. Provide controller with integral power switch. If an integral switch is not provided by the manufacturer, the MSCC shall provide a separate dedicated transformer and switch within each enclosure for each controller present.

e. The operator shall have the ability to manually override automatic or centrally executed commands at the Building Controller via local, point discrete, hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. These override switches shall be operable whether the panel processor is operational or not.

f. Controllers shall provide local LED status indication for power, communications, status and each digital output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

g. All points associated with a given mechanical system (i.e., an air handling unit) will be controlled from a single Building Controller or point expansion panel(s) from the respective master. All expansion modules shall be located in the building controller enclosure or an attached enclosure. No points from a given mechanical system may be distributed among multiple panels - points must be run back to a single Building Controller dedicated to that mechanical system. Multiple mechanical systems shall be allowed on a single controller. Closed-loop control must never depend upon network communications. All inputs, program sequences, and outputs for any single BAS control loop shall reside in the same Building Controller.

h. A variety of historical data collection utilities shall be provided for manual or automatic sampling, storing and displaying system point data.

1) Building Controllers shall store point history data for selected analog and digital inputs and outputs:

i. Building Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control. Provide capability to view or print trend and tuning reports.

1) Loop tuning shall be capable of being initiated either locally at the Building Controller or from a network workstation. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

j. Provide controllers that, upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.

k. Provide additional controllers or I/O modules if necessary, in each BAS panel so that each panel has at least 20% spare universal I/O capacity for connection of future points. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate expansion modules, sensors/actuators and/or field wiring/tubing.

l. Controllers shall provide at least one data communication port for operation of operator I/O devices such as portable laptop operator's terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals. A USB port shall alternatively be available to support local HMI tools connection.

m. Field bus adaptors may be used, as an extension of the B-BC, to facilitate communication between the B-BC and remote field devices (sensors, actuators). Adaptors shall be microprocessor based and utilize advanced diagnostics and configuration. Adaptor shall be housed in panel or junction box enclosure.
n. Any provided JACE controllers shall be by Tridium Vykon and shall be fully open for Owner use and configuration without the need for any proprietary software or licenses.

5. BACnet Advanced Application Specific Controller (B-AAC):

a. Provide controllers conforming to the latest version of ANSI/ASHRAE 135 BACnet Advanced Application Specific Controller (B-AAC) standard device profile and support all of the minimum required BACnet Interoperability Building Blocks (BIBBs) associated with this device profile.
b. Controllers shall support MS/TP communication to B-BC's and other B-AAC's and B-ASC's. Also acceptable are B-AAC controllers that support Internet Protocol (IP) for communications to other BC's/ AAC's and the OIS and MS/TP communication to B-AAC's/ ASC's.
c. Controller shall be a microprocessor-based, 32 bit, multi-tasking, real-time digital control processor capable of stand-alone operation for medium sized mechanical systems and/ or control of roof-top units, VAV terminal units, CAV terminal units, dual-duct terminal units, fan-coil units, heat pump units.

1) If the hardware point requirements of any medium-sized system should exceed the I/O configuration of available B-AAC offerings then a B-BC must be used. Control of one piece of mechanical equipment may not be performed by more than one controller.

d. Controllers shall be peer-to-peer devices with hand/off/auto switches for each digital output. Switch position shall be supervised in order to inform the system that automatic control has been overridden. Switches will only be required for non-terminal applications (not required for VAVs, CAV's and other above terminal devices). All inputs and outputs shall be of the universal type, allowing for additional system flexibility.
e. Each controller shall support its own real-time operating system. Controllers without real-time clock functionality will only be permitted for use on terminal or unitary equipment such as VAV boxes, fan coil units and auxiliary monitoring and control.
f. Provide each controller with sufficient memory to accommodate point databases and operating programs. All databases and programs shall be stored in non-volatile EEPROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
g. Controllers must be fully programmable. All programs shall be field-customized to meet the user's exact control strategy requirements. Controllers utilizing pre-packaged or canned programs shall not be acceptable.
h. All points used for a single mechanical system shall be connected to the same B-AAC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.
i. Provide spare additional I/O such that future use of spare capacity shall require providing only the field device, field wiring, point database definition and operational sequence programming changes as required. Additional point modules may be required to implement use of these spare points.

1) Provide at least one (1) spare universal input and one (1) spare universal output or 15% spare I/O of the total capacity of each B-AAC whichever is greater.
2) If B-AAC I/O is not universal then provide at least one (1) spare analog input, one (1) spare digital input, one (1) spare analog output and one (1) spare digital output or 15% spare I/O of the total capacity for each point type of each B-AAC whichever is greater.

6. BACnet Application Specific Controller (B-ASC):

   a. Provide controllers conforming to the latest version of ANSI/ ASHRAE 135 BACnet Application Specific Controller (B-ASC) standard device profile and support all of the minimum required BACnet Interoperability Building Blocks (BIBBs) associated with this device profile.
   b. Controllers shall support MS/TP communication to B-BC's, B-AAC's and other B-ASC's.
   c. Controller shall be a microprocessor-based, 32 bit, multi-tasking, real-time digital control processor capable of stand-alone operation for control of mechanical terminal units, i.e. VAV terminal units, CAV terminal units, air terminal units, dual-duct terminal units, fan-coil units, heat pump units and roof-top units.
   d. Each controller shall be capable of sharing point information with other B-BC, B-AAC, or B-ASC on a peer-to-peer basis via the BACnet network.
   e. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. All inputs and outputs shall be of the universal type (outputs may be utilized either as modulating or two-state). Analog outputs shall be industry standard signals such as 24V floating control and 0-10VDC allowing for interface to a variety of modulating actuators.
   f. Provide each controller with sufficient memory to accommodate point databases and operating and application programs. All databases and programs shall be stored in non-volatile EEPROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
   g. Each controller shall perform its primary control function independent of other BAS controller communications, or if communication is interrupted. Reversion to a fail-safe mode of operation during network interruption is not acceptable. Controller shall receive its real-time data from the Building Controller time clock to ensure network continuity.
   h. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) values for all applications. All PID values and biases shall be field-adjustable by the user via operator terminals.
   i. Controllers shall provide diagnostic LEDs for power, communications and processor status. The controller shall continually check the status of its processor and memory circuits
   j. All points used for a single mechanical terminal unit shall be connected to a dedicated B-ASC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.
   k. Controllers shall perform and manage historical data collection. Minimum sampling time shall be configurable with a minimum sample rate of once per second. Controller shall store point history files for all analog and binary I/O's.

7. Controllers used for air terminal units (VAV's, CAV's, dual-duct mixing boxes):

   a. Provide electronic damper operators compatible with the controller and the air terminal units provided. Actuator shall utilize a brushless DC operator, min 35 in-lbs. of torque, floating control (unless noted otherwise).
   b. Controllers shall have an internal differential pressure transducer(s) capable of utilizing the total and static pressure signals from the air terminal unit's velocity sensor. Transducer shall be capable of 5% accuracy throughout its range of 0-1"wc. Associated velocity sensor shall be furnished by air terminal unit manufacturer.
   c. Each controller shall have electronic outputs compatible with the electronically operated air terminal unit tempering coil control valve and perimeter radiation control valve where applicable.
   d. Provide a discharge air sensor, mounted on the discharge of the terminal box reheat coil and/ or the outlet of dual duct mixing boxes, interfaced with the controller.
   e. Each controller shall include provisions for automatic calibration of the differential pressure transducer in order to maintain stable control and prevent drift over time. The method of stroking the terminal unit damper to a 0% position shall not be permitted should the controlled space(s) require constant pressurization that would be compromised if the controller would require closing the VAV box damper. MSCC shall provide alternate controllers, programming and/or auxiliary devices (i.e. an 'auto-zero' auxiliary device(s) which functions to temporarily disengage the transducer from the air velocity sensor so that a 0 cfm air volume reading is forced without changing the damper position) when serving these spaces to prevent negatively affecting room pressurization.

f. If coordinated with mechanical contractor, controllers shall be furnished to the unit manufacturer for factory mounting; otherwise, controls shall be field installed.
g. MSCC shall provide controllers with metal enclosure, complete with conduit knockouts.

8. Provide and fully implement the following application function (algorithms) in the BAS Panel. The following functions shall be operator assignable to each BAS panel.

a. Time and Calendar based Scheduled Operation
b. Automatic daylight savings time switchover
c. Optimum Start/Stop
d. Night Cycle Program
e. Night Purge Program
f. Reset Program for Set point Adjustment
g. Ventilation (Economizer) Program
h. Analog and Binary
i. Energy Calculations
j. Software Interlock
k. Trouble Diagnosis
l. Direct digital control loops for temperature control functions

B. Panel Enclosures:

1. Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Enclosures shall not be mounted directly on HVAC equipment such as air handling unit housings. Provide common keying for all panels.

a. Fabricate panels of 0.06 inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.

C. Networking Devices:

1. BACnet IP Routers:

a. BACnet router between MS/TP and B/IP (BACnet over IP) as well as a BBMD (BACnet Broadcast Management Device) for transportation of BACnet broadcasts over an IP network with several subnets.
b. Router shall comply with latest version of ASHRAE Standard 135 for communications.
c. Routers shall be UL864 listed when connected to BACnet MS/TP network segments that contain UL864 listed devices being used in a smoke control application.
d. Device shall be capable of routing BACnet packets over layer 3 IP network and shall support both the router and BACnet Broadcast Management Device (BBMD) networking options. BBMD shall support registrations by Foreign Devices.
e. 24 VAC power supply required for router(s) shall be provided by the MSCC.
f. Device shall be password protected with customizable password and security settings.

D. Power Supplies:

1. Power to controllers and associated controlled devices shall be 24 VAC, provided by the MSCC. Unless otherwise noted, power source (i.e. normal vs. emergency power) shall match that of the equipment being controlled.
2. Provide each DDC panel with a line filter, surge suppressor, electrical disconnect, control fuse, and control transformer. All sized and provided by the MSCC.
3. Provide fully enclosed power supplies located inside control enclosures with external 24 Vac terminals, on/off control, equipment overcurrent protection, power indication, high/low voltage separation, and convenience 120VAC outlets.
4. Provide insulated, modular, feed-through, clamp-style terminal blocks suitable for rail-mounting with end plates and partitions for the termination of all field wiring in control enclosures. Field wiring to

equipment with integral terminals and/or unitary equipment (i.e., VAV's, EF's, etc.) shall not be required to have terminal blocks.

5. Provide a minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger. The backup power source shall have sufficient capacity to maintain volatile memory in event of an AC power failure.

2.5 ACTUATORS AND OPERATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action as indicated.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Non-spring Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
4. Non-spring Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper or Large-Valve Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch pounds/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch pounds/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch pounds/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch pounds/sq. ft. of damper.
    e. Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1,000 to 2,500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
    f. Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2,500 to 3,000 FPM: Multiply the minimum full-stroke cycles above by 2.0.

3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
6. Temperature Rating: Minus 22 to plus 122 deg F.
7. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
8. Run Time: Maximum 90 seconds
9. Fast Acting Actuator Run Time: Maximum 10 seconds

2.6 CONTROL VALVES

A. Valves shall be provided according to the details of this section, and in compliance with the related specification section "Valves".

B. Valves shall be factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Valves shall be sized based on indicated system design flowrates, pressures, and temperatures.

D. Valves and actuators shall be selected with suitable close-off pressures for the application.

E. Unless indicated otherwise, valve bodies NPS 2 inches and smaller shall be bronze with screwed end connections. Valve bodies NPS 2-1/2 inches and larger shall be cast iron with flanged end connections.

F. Manufacturer: Unless noted otherwise, valves shall be Belimo, Honeywell, Johnson, Siemens, or approved equal.

G. Ball Valves (Water):

1. Fluid: Chilled or hot water (up to 50% glycol)
2. Pressure rating: 125 psi water
3. Temperature rating: 250°F water
4. Materials:

    a. Valve body: Bronze
    b. Seat: PTFE
    c. Seals: EPDM
    d. Ball: Nickel or chrome plated brass

5. Sizing: 5 psig maximum pressure drop at design flow rate.
6. Modulating valve flow characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

H. Globe Valves (Water):

1. Fluid: Chilled or hot water (up to 50% glycol) or steam
2. Pressure rating: 125 psi
3. Temperature rating: 250°F (water), 338°F (steam)
4. Materials:

    a. Valve body: Bronze (2 inch and smaller), cast iron (2-1/2” and larger)
    b. Seat: Stainless steel, Bronze (water 2 inch and smaller)
    c. Seals: EPDM

5. Sizing: 5 psig maximum pressure drop at design flow rate.
6. Modulating valve flow characteristics: Two-way valves shall have equal percentage characteristics; three-way hydronic valves shall have linear characteristics.

I. Resilient Seated Butterfly Valves:

1. Fluid: Chilled or hot water (up to 50% glycol)
2. Pressure rating: 125 psi
3. Temperature rating: 250°F
4. Rangeability: Minimum 10:1
5. Materials:

    a. Valve body: Ductile iron, full lug
    b. Disc: Stainless steel
    c. Shaft: Stainless steel
    d. Seat: EPDM
    e. Seals: EPDM

6. Sizing: 5 psig maximum pressure drop at design flow rate.

J. High Performance Butterfly Valves (Water):

1. Fluid: Chilled or hot water (up to 50% glycol)
2. Pressure rating: 125 psi
3. Temperature rating: 250°F (water)

4. Rangeability: Minimum 100:1
5. Materials:

   a. Valve body: Carbon steel, full lug
   b. Disc: 316 stainless steel
   c. Shaft: Stainless steel
   d. Seat: RTFE
   e. Seals: TFE

6. Sizing: 5 psig maximum pressure drop at design flow rate.

K. Control Valve Systems Application:

1. Hydronic heating or chilled water:

   a. 2 position valves:

      1) 2 inch and smaller: Ball valve
      2) 2-1/2 inch and larger: Resilient seated butterfly valve

   b. Modulating valves:

      1) 2 inch and smaller: Ball valve
      2) 1 inch to 6 inch: Globe valve
      3) 4 inch and larger: High performance butterfly valve

2.7 CONTROL DAMPERS

A. Dampers: AMCA-rated, airfoil type parallel and opposed-blade design by an ISO 9001 accredited manufacturer; 13 gauge minimum, galvanized-steel frames; damper blades shall not be less than 16 gauge galvanized steel or aluminum with maximum blade size of 8 inches wide and 48 inches long.

1. Unless otherwise noted, dampers intended for two position operation shall be parallel blade, and dampers intended for modulating control shall be opposed blade.
2. Face and bypass dampers shall be sized to pass 100% of the associated unit rated airflow.
3. Provide required drive axles, linkage, jackshafts, and accessories for proper damper operation. All linkages shall be located outside of the airstream.
4. Damper blades, frames, linkages, jackshafts and other parts of the damper actuation system shall not distort or rack during operation.
5. Dampers shall close tightly, and operate in a smooth, hesitation and slack-free manner over the entire range of travel, at the maximum air pressure and velocity at the mounting location.
6. Multiple section dampers shall operate in unison section-to-section.
7. Dampers shall include blade and edge seals as necessary to achieve maximum leakage of 4 CFM per sq. ft. of damper area at 1.0” WC pressure.
8. Operating Temperature Range: From minus 40 to plus 200 deg F.
9. Static Pressure Rating: Shall be selected to withstand the maximum pressure to be encountered upon closure at the installation location, but not less than 4.0” WC.
10. Dampers shall be supported by properly reinforcing the ductwork at damper locations to carry the weight of the dampers, or shall be supported independent of ductwork, from the structure or floor as conditions at the site dictate. Both sides of damper frame shall be caulked.
11. Dampers which will be exposed directly to weather shall have stainless steel axles, bearings, bushings, and fittings. Dampers which open directly to outdoors from a room such as mechanical or electrical room ventilation, shall include 1" of 1-1/2 lb. density insulation sandwiched in 16 gauge zinc coated steel blades. Bearings shall be oilite bronze.
12. Manufacturers: Dampers shall be Ruskin, Vent Products, or approved equal. Use insulated dampers as indicated on the drawings.

2.8 TEMPERATURE AND HUMIDITY INSTRUMENTS

A. Temperature Sensors:

1. Resistance Temperature Detectors (RTD): Platinum.

   a. Single point duct mounted RTD shall be rigid bulb type, with probe length selected accordingly for measurement near center of the duct cross sectional area
   b. Averaging point duct mounted RTD sensor probe(s) shall be selected to appropriately cover the full duct/coil cross sectional area at the location of installation
   c. Outside air RTD shall have sun shield to minimize solar effects and shall be mounted to minimize building outside air film effects
   d. Immersion Type - shall be suitable for immersion into fluids in pipes with separable well and heat transfer compound, which shall be compatible with the sensors
   e. Space temperature with a range of 55 to 95 degF, plus or minus 0.5 degF resolution, for conditioned space. Space temperature sensors installed at building exterior entrances shall include temperature sensing down to 20 degF for freeze risk monitoring.
   f. Duct temperature with a range of 20 to 120 degF, plus or minus 0.5 degF resolution
   g. Outside Air (OA) temperature with a range of minus 40 to plus 130 degF, plus or minus 2 degF resolution
   h. Liquid immersion temperature sensors shall include probe with SS well, and weather tight enclosure. Sensors shall include a calibrated span of 20 to 120 degF or 30 to 250 degF for heating applications.

2. Sensors installed in wet service locations (i.e. natatorium, piping tunnels, etc.) shall be waterproof and shall be resistant to chlorine and other cleaning agents. Sensors shall have rust proof and waterproof covers.

B. Low-Limit Temperature Protection (Freeze-Stat):

1. Freeze detection controller shall open a switch (auxiliary contact for BAS alarm indication) in series with fan starter holding coil when temperature falls to controller setpoint. Controller shall be equipped with a minimum of 20 feet of copper capillary tube, which shall be placed to the downstream face of the protected coil. Controller shall be manually reset and shall open the circuit when any 12" length of the capillary reaches setting temperature. Install capillary in a horizontal pattern only. Use multiple detectors as required, do not exceed the manufacturer’s maximum coverage area. Use one thermostat for every 20 sq. ft. of coil surface. Install freezestat on face and bypass coils precisely per the face and bypass manufacturer's instructions. The capillary tube shall cover only one vertical section of coil and shall not extend across any bypass portion.

C. Humidity Sensors:

1. Humidity sensor shall use a thin film capacitive sensing element to measure the relative humidity (RH) over a range of 0% to 100% RH. Accuracy shall be +/-2% RH.
2. Humidity transmitters shall be suitable for one or more of the following mounting methods:

   a. Room Type: Shall be suitable for wall mounting with enclosure where located in a finished space.
   b. Insertion Type: Shall be suitable for insertion into air ducts at any angle and shall have a minimum insertion of 6 inches.

3. Sensors installed in wet service locations (i.e. natatorium, piping tunnels, etc.) shall be waterproof and shall be resistant to chlorine and other cleaning agents. Sensors shall have rust proof and waterproof covers.

D. Thermostat:

1. DDC Thermostat: Thermostat for connection to DDC controllers.

   a. Space temperature sensor with a range of 55 to 95 degF, plus or minus 0.5 degF resolution. Thermostats installed at building exterior entrances shall include temperature sensing down to 20 degF for freeze risk monitoring.
   b. Digital temperature display
   c. Temperature setpoint adjustment
   d. Override button
   e. Provide with auxiliary communications port to allow remote connection to DDC controllers.
   f. Thermostat shall be provided with additional options and features as necessary to accommodate functions detailed in the project drawings.

2. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-position, push-button or lever-operated fan switch. These line voltage thermostats control heating, cooling or year round air conditioning units in commercial, industrial or residential installations. Typical uses are for unit heaters, fan coils, blast coils, refrigerated storage room, electric heat, duct furnaces, greenhouses, etc.

   a. Concealed auto-off-fan selector switch
   b. Thermostat shall be placed where air circulates around it freely
   c. Never install the thermostat on or near an outside wall
   d. Keep the thermostat away from windows and doors
   e. Do not locate the thermostat away from windows and doors
   f. Do not locate the thermostat too close to a strong light or any other false source of heat such as direct sunlight, steam lines, etc.
   g. Mount the thermostat on a post or partitioning wall, but make sure that there are no pipes or ductwork in that wall or in the other side of the wall
   h. Mount in a vertical position

3. Electric solid-state, microcomputer-based room thermostat.

   a. Automatic switching from heating to cooling
   b. Preferential rate control to minimize overshoot and deviation from set point
   c. Set up for four separate temperatures per day
   d. Instant override of set point for continuous or timed period from 1 hour to 31 days
   e. Short-cycle protection
   f. Programming based on [weekdays, Saturdays and Sundays] [every day of week]
   g. Selection features include deg F or deg C display, 12- or 24-hour clock, keyboard disable, remote sensor, fan on-auto
   h. Battery replacement without program loss
   i. Thermostat display features include the following:

      1) Time of day
      2) Actual room temperature
      3) Programmed temperature
      4) Programmed time
      5) Duration of timed override
      6) Day of week
      7) System mode indications include "heating," "off," "fan auto," and "fan on"

4. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

5. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

    a. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.

        1) Dead Band: Maximum 2 deg F.

6. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
7. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
8. Unless otherwise noted, thermostats and space sensors shall not be located on exterior walls. When installation on exterior walls is required, devices shall be provided with insulated mounting bases.

E. Outside air sensors shall be installed away from exhaust or relief vents, shall not be installed in an outside air intake, and shall generally be located to provide the best possible sensing of actual outside air conditions, free from influence from the building or operational activities. Sensors shall be installed on a North exterior building wall or an otherwise continuously, year-round shaded location. Outside air temperature sensor shall be provided with a sun shield.

2.9 GAS DETECTION INSTRUMENTS AND SYSTEMS

A. Carbon Dioxide Sensors:

1. Single detectors, using solid-state infrared sensors, suitable over a temperature range of 32 to 120 deg F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output.
2. Manufacturer: ACI, Telaire, Vaisala, Veris

2.10 FLOW INSTRUMENTS

A. Airflow:

1. Duct Mounted Airflow Measuring Station:

    a. Provide where indicated, airflow measuring station(s) capable of continuously monitoring the air volume capacities in which they serve.
    b. Individual airflow traverse probes are not acceptable.
    c. Station shall not be provided with integral air straightener, unless required by ductwork location. If installed ductwork cannot facilitate manufacturer recommended straight duct lengths without straightener, Contractor shall submit an RFI to the project Engineer for direction.

    d. Thermal Dispersion Type Airflow Measurement:

        1) Each station shall consist of one or more multi-point measuring probes and a single microprocessor based transmitter. The transmitter shall be supplied by the same manufacturer as the measuring station or probe array.
        2) Each multi-point probe shall be assembled using heavy wall anodized aluminum tubing, aluminum mounting plates, aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions, and neoprene mounting gasket.
        3) The station shall be connected to the transmitter using a single cable, of up to 100’ in length, included with the transmitter.
        4) Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature.

Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.

5) Each airflow sensor shall have an operating range of 5,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement.
6) Provide a thermal probe array with sensor density level per manufacturer recommendations for the duct size at the installation location.
7) Individual sensors shall be field serviceable without the need for system re-calibration.
8) Each transmitter shall be capable of averaging as many as thirty-two (32) sensors.
9) The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.
10) All transmitter system configurations (Single or Dual Channel), scaling, and diagnostic functions shall be performed via a user interface accessible on the front cover of the transmitter.
11) The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature.
12) The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.
13) Input power to each transmitter shall be 24VAC/24VDC.
14) The stations shall have a 14 ga. [18 ga. for circular units] galvanized steel, 8” deep, welded casing with 90º formed flanges.
15) The transmitter shall be provided integrally mounted to the station or with interconnect cable for remote mounting up to 100’ away.
16) When installed per the manufacturer’s minimum installation requirements, the transmitter with accompanying station or probe array shall measure with an accuracy of ±2-3% of actual flow.
17) Manufacturer: Ebtron, Air Monitor

2. Fan Inlet Mounted:

a. Provide where indicated, airflow probes mounted in the fan inlets capable of continuously measuring the air handling capacity (air volume) of the respective fan(s).
b. Velocity Pressure Type Airflow Measurement:

1) The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
2) The fan inlet airflow traverse probes shall have symmetrical averaging signal takeoffs, and shall be of aluminum construction with hard anodized finish [copper construction] with galvanized steel mounting hardware.
3) The fan inlet airflow traverse probes shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
4) The transmitter shall be capable of receiving flow signals (total and static pressure) from airflow probes and produce dual outputs linear and scaled for air volume, velocity, differential pressure, etc.
5) The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.
6) The transmitter will be available in multiple natural spans covering the range of 0.05 IN w.c. to 10.0 IN w.c. with an accuracy of 0.1% of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining

linear output signals on applications requiring 10 to 1 velocity (100 to 1 pressure) turndown.

7) The transmitter shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source.

c. Thermal Dispersion Type Airflow Measurement:

1) For a single inlet fan, each probe array shall consist of one pair of single-point measuring probes and a single microprocessor based transmitter. For a double inlet fan, each probe array shall consist of two pairs of single-point measuring probes and a single microprocessor based transmitter. The transmitter shall be supplied by the same manufacturer as the probe array(s).
2) Each probe array shall be assembled using heavy wall anodized aluminum tubing, stainless steel adjustable support struts, stainless steel mounting brackets, and an aerodynamically optimized molded sensing apertures to ensure accurate measurement in angular airflow conditions.
3) Probe arrays shall be connected to the transmitter using cable of up to 100' in length, included with the transmitter.
4) Each stand-alone sensing point shall use an ambient temperature thermistor and an externally heated thermistor to determine the point velocity and temperature. Automatic equal area averaging of the individual point measurements shall be performed in the transmitter.
5) Each airflow sensor shall have an operating range of 0-10,000 FPM, with a NIST traceable accuracy of ±2% of reading for velocity measurement and 0.1ºF for temperature measurement. Individual sensors shall be fully field serviceable without need for field calibration, not requiring that the probe be returned to the Factory for repair and/or calibration.
6) Each transmitter shall be capable of averaging as many as thirty-two (32) sensors.
7) The transmitter will have a high visibility backlit LCD for display of either the averaged or individual sensor airflow and temperature measurements, in user selectable units of measure. The transmitter shall be factory configured to output duct air volume for plug and play operation.
8) All transmitter configuration, scaling, and diagnostic functions shall be performed by means of a password protected, cover mounted membrane keypad.
9) The transmitter outputs shall be dual analog (4-20mA, 0-5VDC or 0-10VDC) for airflow and temperature.
10) The operating temperature range of the transmitter shall be from -20º to 140ºF. The transmitter shall be located where it will be sheltered from water or weather.
11) Input power to each transmitter shall be 24VAC/24VDC.
12) The transmitter shall be provided with interconnect cable for remote mounting up to 100’ away.
13) When installed per the manufacturer’s minimum installation requirements, the transmitter with probe array shall measure with an accuracy of ±3-10% of actual airflow as installed or within ±2-3% of actual flow with field calibration.
14) Manufacturer: Ebtron, Air Monitor

2.11 PRESSURE INSTRUMENTS

A. Air Pressure Sensors:

1. Accuracy: 1% of full scale
2. Duct Mounted Sensors:

a. Provide duct mounted static pressure probe including minimum 3” duct insertion and pressure transmitter connected via pneumatic tubing.
b. Pressure transmitter shall be selected and calibrated for operations between 0 and 200% of the maximum normal operating pressure.

3. Space Pressure Sensors:

   a. Provide two ceiling or wall mount static pressure pickups including filter and differential pressure transmitter connected via pneumatic tubing. Transmitter shall be located to minimize pneumatic tubing length.
   b. Sensing range: -0.10 to +0.10" WC

4. Pressure Switches:

   a. Shall provide electrical switching action upon a sensed pressure differential increase between two points. Sensitivity shall be suitable for the application. Set point shall be adjustable over the full range of the device. Switching action shall SPDT. Electrical switch rating shall be 10 amps at 120 VAC, minimum.
   b. Pressure rating of switch and connecting tubing:

      1) Fan - Rated for 12 inches WC.
      2) Pump – Maximum deadhead system pressure.

   c. Switches used for safety shutdown applications shall be of the manual reset type.

B. Liquid/Steam Pressure Sensors:

1. Accuracy: 1% of full scale
2. Each pressure sensor shall include a pressure pickup line(s) connected to a pressure transducer.
3. Pressure transducer shall be selected and calibrated for operations between 0 and 200% of the maximum normal operating differential pressure.
4. Span and zero shall be individually adjustable.
5. The transducer shall not be damaged by pressures up to 500 psig on either side of the transducer and all wetted parts shall be inert on the presence of up to a 40% concentration of ethylene or polypropylene glycol in water.
6. Provide isolation and drain valves for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
7. Liquid transducers shall be provided with a 5 valve manifold for isolation, calibration and air bleed.

C. Pressure Switches:

1. Shall provide electrical switching action upon a sensed pressure differential increase between two points. Sensitivity shall be suitable for the application. Set point shall be adjustable over the full range of the device. Switching action shall SPDT. Electrical switch rating shall be 10 amps at 120 VAC, minimum.
2. Pressure rating of switch and connecting tubing:

   a. Fan - Rated for 12 inches WC.
   b. Pump – Maximum deadhead system pressure.

3. Switches used for safety shutdown applications shall be of the manual reset type.

2.12 ELECTRICAL COMPONENTS AND ACCESSORIES

A. Components:

1. Control Relays:

   a. Control relays shall be provided with two spare, unused contacts, one normally opened and the other normally closed.
   b. All relays shall be plug-in interchangeable mounted on a circuit board and wired to numbered terminal strips.

c. Start/stop relay module shall provide either momentary or maintained switching action as appropriate for the motor being started.

2. Current Switches:

a. Current Sensing Switches (CS): CS shall be utilized for monitoring motor operation. Switch shall be adjustable so that a contact closure is made any time the motor is operating within a "normal" range (1.25-50 amps). Low motor amps resulting from low loading or belt failure shall indicate "OFF". Induced current from the motor power feed shall power CS. The CS shall provide visual indication (LED's) for output status and sensor power; shall have an adjustable trip set-point to ± 1% of its range from -15 to 60°C; shall be isolated to 600 VAC rms; shall be a self gripping split-core type with an optional drill mount bracket; output shall be N.O., solid state, 1.0 A at 30 VAC/DC with a minimum aperture of .52" x .68" for motor power feed. CS shall be a Hawkeye model #H-608 as supplied by Veris Industries, Inc. or equal.

b. Motor Status: The contractor shall provide and install a current sensing switch on any motor required to have motor status. The split-core current switch shall be clamped around one of the three phase motor conductors. The contractor shall adjust the switch per the manufacturer's recommendations to provide status only when the motor driven device (fan, pump, etc.) is operating normally.

B. Wiring and Conduit:

1. Control wiring and cabling shall be per National Electrical Code (NEC) requirements and equipment manufacturer's recommendation and requirements of the mechanical control systems.

2.13 PNEUMATIC COMPONENTS AND ACCESSORIES

A. Tubing:

1. Copper tubing shall be new hard drawn, air grade, ASTM B75 for 3/8 inch and smaller or type L, ASTM B68 for 1/2 inch and larger, with solder joint or compression type fittings, at the option of the MSCC.
2. Plastic tubing (all sizes) shall be black virgin, polyethylene, ASTM D1248, Type 1, Class C, Grade 5, meeting crack test performance required by ASTM D1693 and be fire retardant (FR) rated. Multi-tube harness material shall be as specified above with a polyester film barrier and vinyl jacket not less than 0.062 inches thick. All non-metallic tubing shall be 1/4" O.D. minimum; micro-sleeve is not acceptable.

B. Differential Pressure Gauges:

1. Description:

a. 2000 Series magnahelic differential pressure gauges shall provide an accurate indication of positive, negative, or differential air pressure. The gauge shall include a 4" (10.2 cm) easy to read dial and frictionless magnetic movement in cast aluminum housing and be resistant to shock, vibration, and overpressure. The 2000 Series has both back and side connections so that it may be either surface or flush mounted. Ranges are available from 0" to 0.25" W.C. up to 10" W.C. Select gauge for normal reading to be not less than 25% of full scale.

2. Features:

a. 2% full scale accuracy
b. Easy to read 4" (10.16 cm) white dial and red tipped pointer
c. Flush or surface mounting
d. Easily accessible zero adjustment
e. Corrosion resistant cast aluminum housing
f. Back and side connections

3. Specifications:

a. Accuracy: ± 2% of FS (3% on -0 and 4% on -00 ranges) throughout range @ 70 °F (21 °C).
b. Overpressure: Relief plug designed to open at 25 psig (172 kPa).
c. Ambient Temperature: 20 °F to 140 °F (-7 °C to 60 °C).
d. Rated Total Pressure: -20" Hg to 15 psig (103 kPa).
e. Connections: 1/8" NPT female high and low pressure taps, duplicated-one pair side and one pair back.
f. Housing: Die-cast aluminum, case and aluminum parts iridate-dipped to withstand 168 hour salt spray test, baked dark gray hammerloid exterior finish.
g. Standard Accessories: Two 1/8" NPT plugs for duplicate pressure taps, two 1/8" pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.
h. Weight: 1.0 lb. (2.0 oz).
i. Warranty: 1 year.

C. Pneumatic/Electric Relays:

1. Electric, two position type, range and element shall be suitable for the service. Single or two pole, normally open or normally closed as required. Pneumatic signal setpoint shall be adjustable over the full range. Switch rating shall be 15 amps at 120 VAC.

D. Electric/Pneumatic Relays:

1. Electric, two position type, range and element shall be suitable for the service. Shall be suitable for field or panel mounting, have a 120 VAC coil, and 3 or 4 ports as applicable.

E. Electric/Pneumatic Transducers:

1. Transducers shall convert electronic signals from the DDC controller to linear proportional pneumatic signals for all DDC controlled modulating pneumatic devices.
2. Shall be a panel-mounted device with hand/auto switch, override dial for manual override control, and an output pressure gauge.
3. Shall be selected with a pneumatic output signal range to match the pneumatic actuators served.
4. Output accuracy shall be 1/4 psig at 75°F.
5. Shall be high capacity non-bleed devices with a minimum output capacity as necessary for the application, except special circumstances that require a constant bleed controller with branch exhaust on signal loss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Label every single control device and component including, but not limited to, space sensors, well sensors, AFS's, control panels, damper actuators, VAV box controllers, valves, outdoor air sensors, relays, pressure sensors, differential pressure transmitters, pressure switches, etc. Label must include plain English descriptor and BAS point ID that matches the ID on the OWS exactly.

B. Verify that conditioned power supply is available to control units and operator workstation.

C. Verify that duct-, pipe-, and equipment-mounted devices and wiring and pneumatic piping are installed before proceeding with installation.

3.2 COMMISSIONING

A. This contractor shall make available a qualified technician that is familiar with the installation of this job for technical assistance to the commissioning engineer. No additional paperwork or reports will be required by this process. Where multiple operations in multiple locations are required to test equipment affected under this contract, the appropriate number of staff shall be required.

3.3 INSTALLATION

A. Install equipment level and plumb.

B. Install software in control units and OIS. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve the sequence of operation specified.

D. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate all 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

1. Entrances
2. Public areas
3. Where indicated

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Control wiring in exposed areas and within walls shall be in conduit or EMT as specified in the Electrical Requirements - Division 26.

B. Low voltage control wiring in plenum areas and ceiling cavities shall be plenum rated cable installed parallel or perpendicular to the building structure. Install control wire in bridle rings every 10’ and change in direction. Label control wire as such at each bridle ring. **This item will be strictly enforced.**

C. Space sensor wires that cannot be run within a wall cavity shall be run in one-piece steel surface raceway (Wiremold V500 or equal) and painted to match the existing finish. Fill and patch any cavities left by previous sensors. Paint to match existing finish.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.

B. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 SENSORS, RELAYS, CONTROLS AND ASSOCIATED COMPONENTS

A. Location – Accessibility:

1. Locate controls, relays, instruments, switches, valves, devices and accessories so they are readily accessible for adjustment, service and replacement or as indicated. Conceal tubing, sensing lines, cables and capillaries in all areas except equipment rooms and other unfinished spaces. Install and route tubing, sensing lines, cables, capillaries and conduits parallel and perpendicular to building steel in parallel banks with changes of direction made at 90 degree angles.

B. Location – Sensing Air:

1. Locate, size, and support temperature sensing elements in air streams to properly sense the representative temperature. In the case of controlling, transmitting and indicating elements, the sensing device shall be located, sized and of the type to sense the average condition. In case of safety elements, the sensing device shall be located and of the type to sense the extreme condition.
2. Sensing elements in double wall casings and insulated ducts shall have the entire active portion within the air stream.

C. Insulation:

1. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Where control devices are to be located on insulated surfaces, provide brackets to clear the finished surface of the insulation avoiding punctures of the vapor seal.

3.7 VIBRATION ISOLATION

A. Components:

1. Provide vibration isolation for controllers and components, either by location or by mounting devices.

B. Conduit and Tubing:

1. Install tubing and conduit to preclude nullification of provisions for vibration isolation of equipment and ducting. Mount single tube runs in aircraft type clamps containing an elastomer insert. Mounting shall prevent contact with ducting and air handling unit housing, casing or enclosure. Multiple runs shall conform to the same isolation requirements but details of mounting shall be submitted for approval. Provide looped rubber hose connection when tubing crosses flexible duct and equipment connectors.

3.8 FASTENING TO BUILDING STRUCTURES

A. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to approval by the AE. Submit shop drawings or samples for approval before proceeding with the work.

B. Drilling, welding or the use of explosive driven fasteners on building structures shall require written prior approval by the AE for each type of application except where indicated.

C. Equipment shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions.

D. Electrical equipment mounted against exterior masonry walls shall be mounted at least 1 inch away from the wall surface.

3.9 FIELD QUALITY CONTROL

A. After the inspection has been completed, check systems for continuity.

B. After completion of system installation, the Contractor shall test, adjust, and readjust as necessary, all control equipment in terms of design, function, systems balance, performance, and otherwise make ready for air handling systems acceptance tests.

C. After systems acceptance and after the systems have operated in normal service for two weeks, check the adjustment on instruments and devices and correct items found to be out of order. When systems are in specified operating condition, and other pertinent specifications have been complied with, temperature

control systems will be accepted for heating, ventilating and air conditioning systems. Readjustments necessary to accomplish the specified results shall be made during the warranty period upon request.

D. Coordinate with system manufacturer's representative the time of the final system check.

E. Provide equipment to check the calibration of instruments. Instruments not in calibration shall be recalibrated to function as required, or shall be replaced.

F. Calibrate and adjust control devices, linkages, accessories, and components for stable and accurate operation to meet the design intent and to obtain optimum performance from the equipment controlled. Final adjustment, calibration and checking shall be performed while the respective controlled systems are in full operation. Cause every device to automatically function as intended to ensure its proper operation.

G. After calibrations, adjustments, and checking have been completed and systems are operational, demonstrate to the administrative authorities having jurisdiction and to the AE the complete and correct functioning of all control systems and equipment. These demonstrations shall consist of operating the controls through their normal full ranges and sequences. Simulate abnormal conditions to demonstrate proper functioning of safety devices. Readjust settings to their correct design values, and after sufficient time, observe ability of controls to establish the desired conditions, noting abnormal deviations. Make necessary repairs, replacements or adjustments on items which fail to perform satisfactorily and repeat tests to demonstrate compliance with the design intent.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs.
3. Review data in maintenance manuals.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.11 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

3.12 OWNER’S INSTRUCTION

A. The MSCC shall Provide a training program encompassing equipment and systems for client's operating and maintenance personnel. Coordinate training schedule with the Owner.

B. Training staff shall include Contractor's personnel supplemented by equipment manufacturer's engineering representative.

C. Utilize corrected equipment and system shop drawings, manuals, demonstration apparatus and installed, functioning equipment.

D. During system commissioning and when acceptable performance of the system hardware and software has been established, provide on-site operator and maintenance personnel instruction. Instruction shall be by acceptable competent Contractor Representatives familiar with the systems and computer software, hardware, and accessories.

E. Provide 4 hours of "classroom" instruction to the client's personnel on the operation of DDC System equipment. Operator instruction shall include the overall operational program, equipment functions (both individually and as part of the total integrated system), commands, advisories, and appropriate operator intervention required in responding to the systems operation. Use the operating and maintenance manuals described above as texts during the instructional period. Instruction shall also include description of the chronological information flow from field sensors, contacts and devices to the DDC System. The overview of the system's communication network shall be to provide an understanding to the client's personnel of the interplay between initiating devices, data gathering locations, loop communications and their importance within the DDC System.

END OF SECTION 23 0900

SECTION 23 2123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following categories of hydronic pumps for hydronic systems:

1. In-line circulators
2. End-suction pumps

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For pumps to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. In-Line Circulators:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Division of ITT Fluid Technology Corporation
   c. Taco; Fabricated Products Division

2. Flexible-Coupled, End-Suction Pumps:

   a. Buffalo Pumps, Inc.; an Ampco Pittsburgh Company
   b. Deming Division; Crane Company
   c. Goulds Pumps, Inc.
   d. Ingersoll-Dresser Pump Company
   e. Peerless Pump Company
   f. Taco; Fabricated Products Division

2.2 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.

C. Motors Indicated to Be Energy Efficient: Minimum efficiency as indicated according to IEEE 112, Test Method B. Include motors with higher efficiency than "average standard industry motors" according to IEEE 112, Test Method B, if efficiency is not indicated.

2.3 IN-LINE CIRCULATORS

A. Description: Horizontal, in-line, centrifugal, single-stage, bronze-fitted, radially split case design; rated for 125 psig minimum working pressure and a continuous water temperature of 225 deg F.

1. Casing: Cast iron, with threaded companion flanges for piping connections, and threaded gage tappings at inlet and outlet connections.

   a. Connection Option: Unions at connections for casings that are not available with threaded companion flanges.

2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
3. Impeller: ASTM B 36/B 36M, rolled-temper-brass fabrication, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
4. Shaft and Sleeve: Steel shaft with oil-lubricated copper sleeve.
5. Seals: Mechanical type. Include carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.

6. Pump Bearings: Oil-lubricated, bronze journal and thrust type.
7. Motor Bearings: Oil-lubricated, sleeve type.
8. Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
9. Motor: Resiliently mounted to pump casing.

2.4 FLEXIBLE-COUPLED, END-SUCTION PUMPS

A. Description: Base-mounted, centrifugal, flexible-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, radially split case design; rated for 175 psig minimum working pressure and a continuous water temperature of 225 deg F.

1. Casing: Cast iron, with flanged piping connections, drain plug at low point of volute, threaded gage tappings at inlet and outlet connections, and integral feet or other means on volute to support weight of casing and attached piping. Casing shall allow removal and replacement of impeller without disconnecting piping.
2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.
3. Wear Rings: Replaceable, bronze casing ring.
4. Shaft and Sleeve: Steel shaft with bronze sleeve.
5. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.
6. Coupling: Flexible-spacer type, capable of absorbing torsional vibration and shaft misalignment; with flange and sleeve section that can be disassembled and removed without removing pump or motor.
7. Coupling Guard: Steel, removable, and attached to mounting frame.
8. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate for mounting pump casing, coupling guard, and motor. Field-drill motor-mounting holes for field-installed motors.
9. Motor: Secured to mounting frame, with adjustable alignment.

2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle or straight pattern, 175 psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175 psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.

1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Install pumps according to manufacturer's written instructions.

1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so piping is not supported by pumps.

D. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers. Install seismic bracing as required by authorities having jurisdiction.

E. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.3 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting them on foundations, after grout has been set and foundation bolts have been tightened, and after piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install suction diffuser and shutoff valve on suction side of base-mounted pumps.

F. Install triple-duty valve on discharge side of base-mounted pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tappings where provided.

I. Install temperature and pressure-gage connector plugs in suction and discharge piping around each pump.

J. Install check valve and ball valve on each condensate pump unit discharge.

K. Install electrical connections for power, controls, and devices.

L. Electrical power and control wiring and connections are specified in Division 16 Sections.

M. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 COMMISSIONING

A. Verify that pumps are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.

C. Perform the following preventive maintenance operations and checks before starting:

1. Lubricate bearings.
2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
5. Check suction piping connections for tightness to avoid drawing air into pumps.
6. Clean strainers.
7. Verify that pump controls are correct for required application.

D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
2. Open sealing liquid-supply valves if pumps are so fitted.
3. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
4. Open circulating line valves if pumps should not be operated against dead shutoff.
5. Start motors.
6. Open discharge valves slowly.
7. Check general mechanical operation of pumps and motors.
8. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

E. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 01 "Closeout Procedures."
3. Review data in maintenance manuals. Refer to Division 01 "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 2123

SECTION 23 3100 - HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ductwork Construction and Application Schedule
2. Ductwork materials, plenums, construction, fabrication and support
3. Galvanized steel ductwork
4. Round and flat oval ductwork
5. Reinforcing and supports
6. Flexible nonmetallic duct
7. Double-walled panels, plenums, and duct at outside air intake plenums
8. Blank-off panels for unused louver areas
9. Bellmouth connections
10. Duct liner
11. Duct sealants
12. Duct cleaning and disinfecting
13. Duct installation, sealing, inspection, and leakage testing

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", 2005 and performance requirements and design criteria indicated in the “Ductwork Construction And Application Schedule” that follows in this Section.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", 2005.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Project specific duct fabrication schedule including materials, methods of installation, and location of fitting types. Indicate the metal gage and reinforcement method intended for each pressure classification and size of duct.
2. Construction details for double wall duct and panels, plenums, stacks, canopy hoods, etc.
3. Double wall duct and panel fill material
4. Hangers and supports
5. Duct fittings (manufacturer supplied and contractor fabricated)
6. Turning vanes
7. Duct sealant
8. Flexible duct

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes, configuration and static-pressure classes.
3. Elevations indicating top and bottom height of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Penetrations through fire-rated and other partitions.
6. Equipment installation based on equipment being used on Project.
7. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
8. Hangers and supports, including methods for duct and building attachment

1.5 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise.

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 A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, And Flat Bar.

E. ASTM B 209 & 209M – Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.

F. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.

G. NFPA 90B – Standard for the Installation Of Warm Air Heating and Air Conditioning Systems.

H. SMACNA – All standards

I. AWS - All applicable standards

J. UL 181, 181A, & B – Factory-made Air Ducts and Connectors and Closure Systems

K. UL 723 – Standard for Surface Burning Characteristics of Building Materials

L. Air Diffusion Council – Flexible Duct Performance and Installation Standards

M. National Air Duct Cleaners Association (NADCA).

PART 2 - PRODUCTS

2.1 GENERAL

A. Provided duct and fittings of G90 galvanized steel unless otherwise indicated.

B. Construct duct and fittings in compliance with SMACNA standards and recommendations and per the additional requirements indicated.

C. Duct dimensions indicated on drawings are inside dimensions. The sheet metal dimensions shall be increased an equivalent amount to accommodate internal liner where liner is indicated.

D. Drawings are diagrammatic and indicate the arrangement of the principal apparatus and ductwork and shall be followed as closely as possible. All the required offsets, rises, drops, fittings and accessories may not be indicated on the drawings, but shall be provided as required for a complete and fully functional system. Carefully investigate structure, finish conditions, and the work of other trades affecting sheet metal work, including work associated with testing, adjusting and balancing, in order to arrange all items accordingly. Provide best possible arrangement to provide maximum headroom and maintenance clearances.

E. In addition to sheet metal ductwork specified herein, provide or install as furnished by other sections, accessories and devices including, but not limited to, smoke detectors, plenums, canopy hoods, control dampers, and blank-off panels at unused louver areas.

F. Provide intake and exhaust/relief air plenums attached to louvers.

G. Alternate Joining Methods: As an alternate to SMACNA joining methods, Contractor may propose proprietary joining systems with performance equivalent to SMACNA for Owner's review and approval.

DUCTWORK CONSTRUCTION AND APPLICATION SCHEDULE

GENERAL SUPPLY/RETURN/TRANSFER/EXHAUST DUCTWORK

DUCT	PRESSURE CLASS (IN. W.G.)	SMACNA SEAL CLASS	ASHRAE LEAK CLASS	MATERIAL	NOTES
EXHAUST DUCTWORK	-2	A	3	G-90	---
PLENUMS	± 2	A	3	SAME AS DUCTS SERVED	---
ALL OTHER SUPPLY/RETURN/EXHAUST NOT SPECIFICALLY IDENTIFIED	± 2	C	N/A	G-90	---

ABBREVIATIONS
EF = EXHAUST FAN
FCU = FAN COIL UNIT
RF = RETURN FAN
TAU = TERMINAL AIRFLOW UNIT

2.2 DUCTWORK MATERIALS AND FABRICATION

A. General Ductwork Fabrication Requirements

1. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's 2005 "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals

    a. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification
    b. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations

2. Provide fittings, branches, inlets and outlets in such a manner that air turbulence is reduced to a minimum.

3. Turns

    a. Use radius type elbows wherever possible. Where it is not possible to install a 1.5 times width to centerline radius elbow (full radius elbow), use lesser radii configurations, with 'radius-proportional' splitter vanes permanently installed within. No radius shall be less than 1.0 times width. Provide square elbows of equivalent pressure drop in rectangular ducts where radius elbows will not fit or where specifically noted on drawings. Elbows shall be installed with turning vanes in accordance with Related Section "HVAC Duct Accessories." Stamped elbows may be used up to and including a diameter of 12 in.

4. Transitions

    a. Limit transition angles (for each side) to 15 degrees diverging and 30 degrees converging.

5. Take-Off Fittings

    a. For take-offs carrying more than 25 percent of duct main, provide an increasing branch elbow with an inside radius equal to branch duct width. Size branch and main at elbow for equal velocity.
    b. For take-offs carrying 25 percent or less of duct main, provide flanged increased area branch take-off (45 degree entry, "shoe" type) or 45 degree lateral wye takeoffs. Conical fittings shall be used for spiral, round, and oval ductwork.
    c. For take-offs directly to side outlet for register or grille, provide an increased area tap. For take-offs directly to diffusers see appropriate SMACNA figures.
    d. Acceptable take-off fitting manufacturers: Sheet Metal Connectors, Inc.; United Sheet Metal; McGill Airflow LLC; Foremost; Tangent; Flexmaster; SEMCO Inc.

6. Crossbreak or bead rectangular ductwork.
7. Rectangular duct longitudinal seams shall be Pittsburgh lock 3/8 in. minimum pocket.
8. Bolts and Fasteners

    a. Carbon steel, zinc coated per ASTM A153 for G-90 and stainless steel for aluminum and stainless steel ducts.

9. Welding Materials

    a. Refer to SMACNA "Guidelines for Welding Sheet Metal" for applicable requirements.

B. Galvanized Steel Ductwork

1. Minimum steel rectangular duct gage shall be as follows:

    a. Ducts through 12 in. wide: 24 Gage
    b. Ducts 13 in. through 30 in. wide: 22 Gage.
    c. Ducts 31 in. through 84 in. wide: 20 Gage.
    d. Ducts 84 in. and larger: 18 Gage

2. Lock-forming quality ASTM A653, A924 mill galvanized steel sheet, 1.25 oz per sq. ft. zinc coating on each side in conformance with coating designation G-90. Mill-phosphatized finish for surfaces of ducts exposed to view.

C. Galvanized Touch-Up Paint: Inorganic zinc-rich touch up paint containing a minimum of 65 percent metallic zinc by weight for damaged galvanized coating.

1. Acceptable manufacturers/product: Carboline/Carbo-Zinc, Tnemec/Tneme-Zinc

D. Round and Flat Oval Ductwork

1. All round and oval duct shall be manufactured of spiral lock seams, with minimum gage per the appropriate SMACNA Tables and per manufacturers recommendations. Ductwork up to 12 in. diameter and 2 in. w.g. can be manufactured with longitudinal lock seams.
2. Tees shall be conical. Laterals shall be straight. Taps through 10 in. diameter in size shall have a machine drawn entrance and fittings shall have longitudinal seams, continuously welded. Both sides of welds shall be primed with zinc chromate. Tap entrances shall be free of weld build-up.
3. Elbows in diameters 2 in. through 10 in. shall be stamped or pleated. Elbows shall be 5 gore for 90 degrees and 3 gore for 45 degrees. Elbows shall have 1.5 times width to centerline radius (full radius elbow).
4. Flanges, access doors and taps into spiral ducts shall be factory fabricated.
5. Field joints in diameters through 48 in. shall be made with 2 in. long slip-fit, sleeve coupling, or flanges. Ductwork 48 in. diameter and over, and for all sizes where disassembly or removal is required, shall be joined with flanges.

E. Reinforcing and Supports

1. Structural steel per ASTM A36; Mill galvanized per ASTM A653, Coating Designation G-90. Equivalent rolled steel structural support systems (such as TDF or TDC) may be used in lieu of mill rolled structural steel. Use double nuts and lock washers on threaded rod supports.
2. Tie-Rods

    a. Maximum tie rod spacing shall be 42 in., unless specifically engineered in accordance with SMACNA Industrial Rectangular Duct Standard.
    b. Minimum tie rod diameter shall be 1/2 in.
    c. Tie Rods shall not be used in any plenum or ducts that require access.
    d. Tie rods shall not be used in any PCD, cage wash, stainless steel, or ducts carrying lint.
    e. Tie rods shall not be used in any return or exhaust ducts in health care facilities.

2.3 FLEXIBLE DUCT

A. General

1. Flexible duct shall be UL listed, and shall maintain shape when installed. Sagging shall not exceed 1/2 in. per linear foot when installed horizontally.
2. Flexible duct shall not be used where system pressure is greater than plus or minus 2 in. w.g.
3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 1-1/3 in. thick fiberglass insulation blanket, factory wrapped.
4. Flexible duct used on negative pressure systems shall be specifically rated for negative pressure use.
5. For connection to supply, return and exhaust diffusers/grilles located in horizontal ceilings, use pre-fabricated 90 degree plastic supports (Flexflow Elbow by Thermaflex), or 90 degree sheet metal elbow fittings.

B. Flexible Nonmetallic Duct

1. Flexible nonmetallic duct shall be constructed of sound transparent foil. Material shall be mechanically locked to the outside helix. Use of adhesives to lock fabric in place is not acceptable. The helix shall be constructed of corrosion resistant galvanized steel, formed and mechanically locked to the duct fabric on the outside to prevent tearing.
2. Flexible fabric duct shall be rated at 6 in. positive pressure and at 4 in. negative pressure.
3. Flexible nonmetallic duct shall be listed UL Class 1.
4. Acceptable Manufacturers

    a. Flexmaster
    b. Hart & Cooley.
    c. Atco

2.4 SPECIAL DUCTWORK CONSTRUCTION

A. Ductwork required to be removable shall utilize companion flanges.

2.5 DOUBLE-WALLED PANELS, PLENUMS AND DUCT AT OUTSIDE AIR INTAKE PLENUMS

A. Double-walled type panels, 2-1/2-in.-thick, constructed from smooth or embossed mill finish G-90 galvanized steel facing sheets. Each panel shall contain an integral frame of G-90 galvanized steel or extruded aluminum bonded to the facing sheets to provide a moisture-tight seal at the panel perimeter. Panels shall be load bearing and capable of forming the plenum or duct without the installation of structural members. Join panels together with G-90 galvanized steel or extruded aluminum mullions and fasten with closed end rivets. Make connections to the duct or plenum using a support mullion that is an integral part of the panel and not bolted to or through the panel. Gasket all joining mullions with a double vinyl gasket or a double butyl gasket to provide a permanent air-tight seal. Design panel skins, core density, rib spacing, and mullion spacing to eliminate panel pulsation and to a maximum deflection of 1/200 of any span at design pressure, positive or negative. The overall “U” factor of the panels shall not exceed 0.14 BTU/ft²/°F.

B. Removable panels shall be the same construction as described above, with double seals around periphery to guarantee tight closure.

C. Access doors shall be constructed as follows.

1. Doors shall be minimum 24 in. wide whenever possible, or widths as indicated on drawings. Provide doors that are the full height of the panel, maximum 5 ft. high.
2. Each access door shall be equipped with continuous double gaskets and shall fit in the door frame in a manner to guarantee tight closure.
3. Hinges and hardware shall be galvanized, stainless steel or aluminum. Outdoor unit hardware shall be stainless steel, or aluminum. Provide at least 2 handles per door, operable from either side.
4. Access doors in positive pressure sections shall open inward, in negative pressure sections shall open outward.
5. Where indicated, provide a glass window in the access door, minimum 6 in. by 6 in. size, located at a height convenient for viewing, sealed to prevent leakage, rated to operate safely against the duct/plenum pressure rating. Provide double pane insulating type glass at all locations connected to outdoors/exterior or exposed to air temperatures below 55F; single pane at other locations.

D. The manufacturer shall have published literature available stating the coefficient of absorption and the sound transmission loss characteristics of the panels system per ASTM C 423 and the sound transmission loss properties per ASTM E 90 and E 413. Published acoustic data shall show the trademark or name of the manufacturer, shall have been verified by a recognized independent testing laboratory, and shall specify the coefficient of acoustic absorption and attenuation by octave band. Submit acoustic performance data in graphic and tabular form as part of the shop drawings. Minimum panel performance for 2-1/2 inch thick panels shall be as follows:

Frequency	125	250	500	1000	2000	4000
Transmission Loss (dB)	14	22	28	35	43	48
Absorption Coefficient	0.3	0.7	0.95	0.95	0.95	0.85

E. The duct and plenum systems, in addition to supporting indicated equipment, scheduled maximum operating pressure, and system test pressure, shall sustain a 35 lb. per sq. foot maintenance function load without permanent deformation or damage.

F. Acceptable Manufactures.

1. McGill Airflow LLC.
2. SEMCO Mfg Co.
3. Vibro-Acoustics

2.6 BLANK-OFF PANELS FOR UNUSED LOUVER AREAS

A. Provide a minimum 20 gage, G-90 galvanized or aluminum, insulated sheet metal blank-off panels for unused louver sections. Panels may be of the double-walled or single wall insulated type. For double-walled type panels, the insulation shall have an overall “U” factor of 0.14 BTU/ft²/°F. Insulation for single skin panels shall be of the rigid type and of the thickness as specified for outside air intake ducts located in mechanical rooms in Related Section "Mechanical Systems Insulation," permanently secured to the panel skins. Panels shall have a maximum deflection of 1/200 of any span at wind velocities of up to 100 MPH.

B. Exterior/visible face of blank-off panel shall be cleaned and painted flat black, prior to installation.

2.7 BELLMOUTH CONNECTIONS

A. Bellmouth fittings shall be constructed to match material requirements as indicated on drawings.

B. Bellmouth shall have a minimum radius of 1 1/2 in. with 1/2 in. flange and 1/2 in. by 1/8 in. thick neoprene gasket.

C. Acceptable Manufactures.

1. Buckley Associates
2. McGill Airflow LLC
3. SEMCO Mfg Co.

2.8 DUCT LINER

A. General: Comply with NFPA 90A or NFPA 90B and NAIMA's "Fibrous Glass Duct Liner Standard."

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

1. Certain Teed “ToughGuard™ R” with “Enhanced Surface”.
2. Owens Corning “QuietR Textile Duct Liner”.
3. Knauf “Sonic XP Duct Liner”.

C. Materials: Fiber Glass Duct Liner with a factory-applied coated surface exposed to airstream to prevent erosion of glass fibers and a transverse edge coating per SMACNA and NAIMA.

1. Thickness: 1 inch (unless otherwise noted).
2. Model Building Code: ICC
3. Material Standard: ASTM C1071, Type, CAN/CGSB-51.11-92.
4. “GREENGUARD”: Children & Schools.
5. Fire-Hazard Classification: Maximum flame-spread rating of 25 and smoke-developed rating of 50, when tested according to UL 723, ASTM E84, NFPA 255.
6. Limited Combustible: <3500 btu/lb per NFPA 259.
7. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature as tested in accordance with ASTM C518 and/or ASTM C177.
8. Acoustical Performance: 0.70 NRC as tested in accordance with ASTM C423 using Type A mounting per ASTM E795.
9. Maximum operating temperature: 250F per ASTM C411.
10. Maximum operating velocities: 6000 fpm per ASTM C1071. Above duct velocities of 5500 fpm install perforated inner metal liner over the duct liner.
11. Water Vapor Sorption: < 3% by weight per ASTM C665.
12. Corrosiveness: Pass per ASTM C665.
13. Bacteria Resistance: No Growth per ASTM G22.
14. Fungi Resistance: Pass; No Growth per ASTM C1338 and ASTM G21.
15. Water Repellency Rating: > 4 per INDA IST 80.6-92.
16. LEED™: Minimum 25% recycled content based on LEED™ definition.
17. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.

18. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

    a. Tensile Strength: Indefinitely sustain a 50 lb. tensile, dead-load test perpendicular to duct wall.
    b. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.

19. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
20. Ductwork Requiring Lining:

    a. First 15’ of ductwork upstream of exhaust fans.
    b. First 10’ of terminal units.
    c. All transfer ducts.

2.9 DUCT SEALANTS

A. Solvent-based sealants may only be used if the outdoor air temperature will be below 40˚F within 24 hours of applying.

B. Sealant shall be non-asbestos type, and comply with UL and NFPA 90A.

C. Sealant: Water or solvent based elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) specifically for sealing ductwork. Use products as recommended by manufacturer for low, medium or high-pressure systems

1. Acceptable Manufacturers.

    a. Hardcast
    b. McGill Airflow LLC
    c. Polymer Adhesives
    d. Ductmate

D. Tape shall not be used.

E. Gaskets and mastics used for flanged joints shall be compatible for the service of use and per the manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 GENERAL SHEET METAL DUCTWORK INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Ductwork shall be installed to true alignment, parallel or perpendicular to adjacent building walls, floors and ceilings, to present a neat and quality workmanlike appearance.

D. Provide necessary offsets and transitions to avoid interference with the building construction, piping, or equipment. Locate ducts with sufficient space around equipment to allow operating and maintenance activities.

E. Bullhead tees and straight tap connections are not acceptable.

F. Provide straight runs of ductwork, upstream and downstream, at equipment, fans, coils, air terminal units, humidifiers and the like per manufacturer's recommendations and as indicated on drawings.

G. Provide flexible connector where ductwork connects to fans, air handling units (unless internally isolated), other rotating equipment, and where indicated on drawings.

H. Repair damaged galvanized surfaces with zinc rich paint.

I. For ductwork mounted outdoors, install duct with slight lateral pitch to prevent water ponding on top of duct.

J. Enclose dampers located behind architectural intake or exhaust louvers in a sheet metal collar and seal to building construction.

K. Air volume control on parallel flow branches shall be accomplished with branch dampers. Splitter type dampers are not acceptable.

L. Install special equipment items in ductwork systems including, but not limited to: control dampers, thermometers, airflow measuring devices and other related items, according to manufacturer's recommendations.

M. Set plenum doors 6 in. to 12 in. above floor. Arrange door swings so that fan static pressure holds door in closed position.

N. Store duct at least 4 in. above floor on wood pallets or similar devices. Protect duct from odors, dust, moisture, and other debris while stored on or off the jobsite, and when transporting to the jobsite, by tightly covering with plastic.

O. Ductwork openings shall remain protected and covered until just prior to connection. Immediately after assembly, restore all protection to prevent odors, dust, moisture, and other debris from entering ductwork system. Remove any internal labels.

P. Provide required penetrations and sleeves in building structure.

Q. Blank-off panels shall be screwed to louver blades and caulked to provide a weather tight seal.

3.2 FLEXIBLE DUCTWORK INSTALLATION

A. Flexible duct runs shall not exceed 5 ft. long. Cut to length so that it is not compressed. Trim ends squarely. Sag shall not exceed 1/2 in. per linear foot when installed horizontally.

B. Provide a minimum of 3 ft. of flexible non-metallic duct at connections to supply, return and exhaust diffusers/grilles mounted in horizontal ceilings, unless otherwise noted.

C. Support at a maximum spacing of 2 ft. using 4 in. wide sheet metal protection saddles at each duct hanger. Flex duct directional changes shall not exceed 45 deg with centerline radius of bend no less than one-half times duct diameter.

D. For connection to supply, return and exhaust diffusers/grilles located in horizontal ceilings, use pre-fabricated 90 degree plastic supports (such as the Flexflow Elbow by Thermaflex), or 90 degree sheet metal elbow fittings.

E. Apply duct sealant to outside surface of collars and secure with metallic draw-band where flexible duct joins other duct or devices.

F. Flexible duct shall not be used to connect terminal units to branch or main ducts.

3.3 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. All duct liner shall be installed in accordance with the requirements of the NAIMA Fibrous Glass Duct Liner Standard or SMACNA HVAC Duct Construction Standard and the herein requirements.

B. Duct liner shall be kept clean and dry during shipping, storage, job site installation, commissioning and system operation. All lined ductwork shall be protected from any moisture using secured plastic and stored on wood palates until installed. During installation, protect open ended ducts with plastic.

C. The liner shall be cut and fitted to ensure all joints are neatly and tightly butted with no interruptions or gaps. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

D. Provide a perforated inner metal liner over the duct liner in any system with high in duct velocities exceeding 5500 fpm.

E. Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. All duct liner products shall be adhered to the sheet metal ductwork using an adhesive meeting the requirements of ASTM C916.

G. Adhere a single layer (multiple layers of duct liner to achieve indicated thickness are prohibited) of indicated thickness of duct liner with a minimum of 90 percent coverage of adhesive on the metal surfaces. Apply adhesive to duct liner facing in direction of airflow not receiving metal nosing. Mechanical fasteners of the specified type and length shall be used, ensuring no greater than 10% compression of the liner thickness.

H. In Addition to applying adhesive, secure duct liner to the sheet metal ductwork using weld secured mechanical fasteners. Butt transverse joints without gaps and coat joint with adhesive. Secure liner per SMACNA Standards with welded mechanical fasteners, 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

I. Butter all raw edges to coat duct cut-ins and/or minor installation damage.

J. Secure transversely oriented liner edges facing the airstream with metal nosing that have either channel or "Z" profile or are integrally formed from duct wall. Fabricate edge facings at the following locations:

K. Fan discharge.

L. Intervals of lined duct preceding unlined duct.

M. Upstream edges of transverse joints in ducts.

3.4 DUCTWORK HANGERS AND SUPPORTS

A. Generally, hang and support ductwork per the latest edition of SMACNA. Additionally, adhere to the more specific requirements found in this specification section and as indicated on the Project drawings.

B. Hanging duct, equipment, or accessories with cables or wires is prohibited.

C. Comply with Project drawing details regarding hangers, building attachments, fasteners, beam clamps and retaining clips, and as noted below.

D. Provide vibration isolation as specified in the related Specification Section.

E. Ductwork shall be supported and anchored to structure so that horizontal ducts are without sag or sway, vertical ducts without buckle, and so that all ducts are free from deformation, collapse or vibration.

F. Support un-insulated rectangular ducts in sizes to 36 in. by non-perforated galvanized steel strap or by trapeze hangers. Support insulated rectangular ducts and ducts larger than 36 in. with trapeze hangers.

G. Provide at least one support for each length of duct, with a maximum hanger spacing of 10 feet. Install supports on both ends of duct turns, branch fittings and transitions.

H. Do not hang ductwork from piping, ducts, other trades' hangers, existing hangers, or equipment.

I. Single band hangers are not acceptable on ducts greater than 24 in. diameter.

J. Provide supports on each side of any duct mounted equipment or device, including fans, coils, dampers, etc, to permit removal of item without removal of adjacent duct sections.

K. Provide supplemental steel required to support ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned.

L. Beam clamps shall be double sided on ducts over 36 in. by 36 in. Use double sided or single sided beam clamps with retaining clips on all other sizes.

M. Do not modify existing structural steel without approval of Project Manager and a structural engineer's review.

N. Provide clamping systems that are compatible with the structural steel system of the building.

O. Use angle iron "V" construction supports or similarly rigid construction for vertical ducting that requires lateral support.

P. Ductwork mounted on roof or otherwise exposed to elements shall be supported with frames constructed of galvanized steel angles and channels, regardless of duct size. Supports shall not rest on top of roof, but shall be firmly attached to roof structure and properly flashed. Ducts that penetrate through the roof shall utilize curbs and shall be counter-flashed. All fasteners shall be galvanized.

Q. Provide angle sway bracing and diagonal cross bracing to the structure to provide support against maximum lateral loads that may be imposed on the ductwork installed downstream of fan discharges and ductwork exposed to wind loads, and any other locations exposed to lateral loads.

R. All materials used for support in pool and pool mechanical areas shall be fabricated from stainless steel and/or aluminum.

3.5 DUCTWORK PAINTING

A. Where the interior of duct is visible through grilles, registers, diffusers or other air diffusion devices, paint the interior flat black. Coordinate work with Architectural Trade.

B. For plenum returns, where equipment and structure above ceiling is visible through return air grilles, provide black sheet metal baffle with turned edges suspended from building construction. Size and position the baffle to prevent restriction of air flow. Where space above ceiling precludes use of a baffle, paint visible building surfaces flat black.

3.6 TEMPORARY USE

A. Develop a plan that assures ductwork is protected during temporary use. Obtain approval of the plan from the Owner's Representative.

B. Maintain the protection plan until just prior to Owner turn-over.

C. Successfully complete return/negative pressure duct leak testing prior to duct temporary use.

D. Temporary filters shall be provided in return or negative pressure duct to protect ductwork and building contents when any fans are operated during construction. Filters shall have an equal or better performance rating than the air handling unit pre-filters specified for permanent use, but not less than MERV 8, in order to prevent construction dirt infiltration into duct systems. Install filters over grilles, diffusers, and all duct openings. Provide filters over supply grilles, diffusers and duct openings if construction dust and debris will enter when operated for temporary service (e.g. air system cycles off during periods when construction continues). Seal around temporary filters to prevent filter bypass.

E. Continuously maintain all filters and replace when pressure drop exceeds 1 in. w.c., or at manufacturer's recommended change-out pressure drop, whichever is lower.

F. Remove temporary filters and associated materials, and clean any adhesive residue from finished surfaces, at completion of temporary use.

3.7 DUCTWORK SEALING, INSPECTION AND LEAKAGE TESTING

A. Seal, inspect and test prior to insulating or concealing ductwork.

B. Seal all ductwork, regardless of pressure class, to SMACNA Seal Class A (Seal all transverse joints, longitudinal seams, and duct wall penetrations):

1. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment.
4. Spiral lock seams do not require sealing.

C. Perform measured leak testing on the following ductwork:

1. 100% of ductwork that is intended to operate in excess of 3 inches water column
2. 100% of ductwork located outdoors
3. Representative sections totaling no less than 25% of the total installed duct area for each designated pressure class of 3 inches water column and below.
4. 100% of welded ductwork
5. Maximum permissible leakage rate (Lmax in cfm/100 ft2 of duct surface area):

    a. Lmax = 4 x P^0.65, where P = test pressure which shall be equal to the design duct pressure class rating in inches water column.
    b. Welded Ductwork: Zero leakage.

D. Ductwork Leakage Testing Procedures:

1. Prior to fabrication and installation, develop and submit for approval a ductwork testing plan, indicating locations of temporary caps, surface area of ductwork test sections, test pressure, leakage class and allowable leakage in cubic feet per minute.
2. Notify the Owner's Representative at least 2 days prior to each test.
3. Provide all blank-off plates, flanges, and safing required to isolate each section of duct to be tested.

4. Provide necessary testing apparatus.
5. For all ducts, pressurize ductwork to the specified pressure class and inspect ductwork for visual and audible leaks, and leaks perceptible to a hand 2 in. from duct. Reseal all perceptible leaks until acceptable to Owner's Representative.
6. After completing visual and audible inspection, conduct measured ductwork leakage tests at the specified pressure class for the duct. Reseal and retest as required until successfully achieving the specified leakage class.
7. Positive pressure leakage testing is acceptable for negative pressure ductwork.
8. Submit leakage test report for approval, using SMACNA or other approved form.

END OF SECTION 23 3100

SECTION 23 3300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers
2. Manual-volume dampers
3. Turning vanes
4. Duct-mounted access doors and panels
5. Flexible ducts
6. Flexible connectors
7. Duct accessory hardware

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers
2. Manual-volume dampers
3. Fire and smoke dampers
4. Duct silencers
5. Duct-mounted access doors and panels
6. Flexible ducts

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:

1. Special fittings and manual and automatic volume damper installations.
2. Fire and smoke damper installations, including sleeves and duct-mounted access doors and panels.

C. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA standards:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.

C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.

D. Extruded Aluminum: ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4 inch minimum diameter for 36 inch length or less; 3/8 inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL-VOLUME DAMPERS

A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classifications of 3 Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

D. Jackshaft: 1 inch diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.

E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32 inch thick zinc-plated steel, and a 3/4 inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.3 TURNING VANES

A. Fabricate to comply with SMACNA's 2005 "HVAC Duct Construction Standards--Metal and Flexible."

B. Manufactured Turning Vanes: Turning vanes shall be double wall turning vanes fabricated from the same material s the duct. Fabricate of 1-1/2 inch wide, curved blades set 3/4 inch on center; support with bars perpendicular to blades set 2 inches on center; and set into side strips suitable for mounting in ducts.

1. Turning vane front and back panels shall be securely locked together with adequate crimping to prevent twisting of vane. Vane shall be capable of withstanding 250 pounds of tensile load when secured according to the manufacturer’s instructions.
2. Rails for mounting turning vanes shall have self-locking, friction fit tabs designed to facilitate proper alignment of vanes. Tab spacing shall be as specified in Figure 4-3 of the 2005 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Third Edition standard. Rail systems with non-compliant spacing shall not be accepted.

C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill. Mounting rails shall have friction insert tabs that align the vanes automatically.

2.4 DUCT-MOUNTED ACCESS DOORS AND PANELS

A. General: Fabricate doors and panels airtight and suitable for duct pressure class. Provide access doors of adequate size to allow easy access to the equipment that will require maintenance. Provide insulated or acoustically lined doors to prevent condensation where applicable.

B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.

C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1 inch butt or piano hinge and cam latches.

D. Seal around frame attachment to duct and door to frame with neoprene gasket.

E. Insulation: 1 inch thick insulation that does not contain phenol, formaldehyde, acrylics or artificial colors. Certified to GREENGUARD for the industry's most stringent IAQ standard, children in schools.

2.5 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4 inch wide, 0.028 inch thick, galvanized, sheet steel or 0.032 inch aluminum sheets. Select metal compatible with connected ducts.

C. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 4-3/8 inch wide, 0.028 inch thick, galvanized, sheet steel or 0.032 inch aluminum sheets. Select metal compatible with connected ducts.

D. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.

E. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun's ultraviolet rays and ozone environment.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp, and 440 lbf/inch in the filling.

2.6 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2 inch thick, glass-fiber insulation around a continuous inner liner.

1. Reinforcement: Steel-wire helix encapsulated in inner liner.
2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
3. Outer Jacket: Polyethylene film.
4. Inner Liner: Polyethylene film.

C. Pressure Rating: 6 inch wg positive, 1/2 inch wg negative.

2.7 ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.

B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4 inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.8 GRAVITY INTAKE/RELIEF HOODS

A. Manufacturers:

1. Acme Engineering and Manufacturing Corporation
2. Aerovent; a Twin City Fan Company
3. Carnes
4. Greenheck
5. Loren Cook Company
6. Penn Ventilation

B. Factory or shop fabricate according to SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible,” Figures 5-6 and 5-7.

C. Materials: Aluminium sheet, minimum 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inth-thick, rigid fiberglassw insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Built-in raised cant and mounting flange.
2. Overall Height: 18 inches.

E. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and NAIMA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.

C. Provide test holes at fan inlet and outlet and elsewhere as indicated.

D. Install fire and smoke dampers according to manufacturer's UL-approved written instructions.

1. Install fusible links in fire dampers.

E. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.

1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
2. Install access panels on side of duct where adequate clearance is available.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

END OF SECTION 23 3300

SECTION 23 3400 - FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 01 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Centrifugal Fans:

a. Domed roof

1.3 SUBMITTALS

A. Submit the following product data for each unit:

1. Static pressure, airflow (CFM), speed (RPM), system curve, outlet velocity and fan tag for each fan.
2. Certified fan curves showing fan performance with the system operating points identified on curves. Surge, or "Do not operate" line, shall also be indicated on fan curve.
3. Performance curves shall be published by the fan manufacturer and based on tests in accordance with AMCA 210. The curves shall be drawn with the fan flow rate plotted against fan total pressure and fan brake horsepower as per section 10.2.1 of AMCA 210.
4. Bearing sizing and life calculations for each similar size and type of fan. Fan bearing calculations shall be based on fan maximum operating conditions including belt pull. Calculations shall be provided for both fan bearings and motor bearings.
5. Sound power levels for each size and type of fan. Sound levels shall be provided for all 8 octave bands for discharge of fan, inlet to fan, and radiated noise through casing.
6. Dimensional data for each size and type of fan, including operating and maintenance clearances.
7. Details of vibration isolation bases including selections for vibration isolation springs.
8. Details of fan discharge flexible duct connector.
9. Details of motor and belt guards.
10. Motor ratings, electrical characteristics, and motor accessories.
11. Fan anti-corrosion coating data sheets.

1.4 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise.

1. ANSI/AMCA Standard 99-2404, "Drive Arrangements for Centrifugal Fans."
2. ANSI/AMCA Standard 99-2406, "Designation for Rotation and Discharge of Centrifugal Fans."
3. AMCA Standard 99-2408, "Operating Limits for Centrifugal Fans."
4. ANSI/AMCA Standard 260 "Laboratory Methods of Testing Induced Flow Fans for Rating."
5. ANSI/AMCA Standard 300, "Reverberant Room Method for Sound Testing of Fans."
6. ANSI/AMCA Standard 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data."
7. ANSI/AMCA Standard 204, "Balance Quality and Vibration Levels for Fans."
8. UL-705, "Power Ventilators" (applies only for fans exposed to outdoor conditions).
9. UL-762, "Power Roof Ventilators for Restaurant Exhaust Appliances."

10. UL-793, "Standard for Automatically Operated Roof Vents for Smoke and Heat."
11. American Bearing Manufacturers Association (ABMA) Standards.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Fan manufacturer shall provide protection to insure that the interior and exterior of each fan is completely protected from dirt or weather during shipping. Openings shall be covered with sealed sheet metal, plastic or other durable means to ensure unit cleanliness is maintained.

1.6 WARRANTY

A. Provide a complete parts and labor warranty for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. All fan types specified in this Section:

a. Loren Cook Company
b. Greenheck

2.2 GENERAL CONSTRUCTION - ALL FANS

A. Provide balanced variable sheaves for motors 7.5 HP and under and fixed sheaves for motors 10 HP and over. Size variable sheaves at midpoint of specified operating conditions to allow field adjustment up or down during balancing procedures. Where fixed speed sheaves are specified for a specific fan, provide one (1) additional sheave set, if required, for final balancing.

B. Fan selection and ratings shall be based on tests made in accordance with AMCA 210.

C. Fans shall be AMCA licensed and shall bear the AMCA seal for both sound and performance levels.

D. Fan shall be minimum Class I construction with proper UL label.

E. The specified fan RPM, outlet velocity, and tip speed are the maximum acceptable. The motor horsepower, CFM, and static pressure are the minimum acceptable.

F. Unless noted otherwise by specific fan type or per schedule, fan housing shall be heavy gauge continuous welded corrosion resistant steel construction with fan scroll and bearings supported from structural steel framework.

G. All fasteners shall be corrosion resistant type.

H. Fan housing shall be of suitable thickness and bracing required for stable and rigid construction, with no deflection, and to prevent vibration and pulsation.

I. Fans having duct-connected inlets shall be provided with a flanged inlet and/or outlet collar matching companion flange.

J. Provide OSHA belt guards on all belt driven fans.

K. For exterior mounted fans, a weatherproof housing shall be provided with ventilation grilles to cover motor and drive assembly.

L. Provide special construction fans, such as spark-proof, explosion-proof, or specially coated fans as required by schedules or as specified herein.

M. Provide birdscreen on fans exposed to the exterior environment.

N. Provide adequate space for service of fan, motor and bearings.

O. The fan shaft shall be solid high carbon steel, accurately turned, ground and polished, and ring gauged for accuracy.

P. Recommended bearing manufacturer tolerances shall be met in the area of the shaft in contact with the bearings.

Q. Shafts must be dial indicator inspected for straightness after the keys are cut.

R. Fan shaft shall be coated with rust inhibitive coating.

S. Fan wheel assembly or propeller assembly shall be statically and dynamically balanced prior to fan assembly.

T. The entire rotating assembly shall be designed so the first critical speed is at least 25% over the maximum fan class speed.

U. Fan Shaft Bearings:

1. Fan bearings shall be bolted on a rigid welded steel framework integral with the housing.
2. Bearings shall be designed and individually tested specifically for use in air handling applications.
3. Bearings shall be sized for a minimum L-10 life of 200,000 hours at the maximum fan class operating speed and horse power. Selection shall account for all operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the American Bearing Manufacturers Association (ABMA).
4. Bearings shall be grease lubricated self-aligning ball or roller type. Provide tapered roller bearings for vertical applications.
5. Bearing housings shall be solid cast iron, pillow block or flange mount type. Provide split pillow block bearings where required by the application speed.
6. Stamped bearing housings are permitted on fans of 1/4 HP or less.
7. Bearings shall be of the type that can be re-lubricated, and shall be equipped with grease fittings.

V. Where fan bearings are not easily accessible or are installed in a hazardous exhaust airstream, provide clear plastic grease leads, properly secured to avoid damage or fatigue, routed to an accessible location.

W. Fan Drive:

1. Fan drive shall be a multiple V-belt type sized for 1.65 times the fan motor horsepower. Sheaves shall be fixed or adjustable based on fan motor horsepower as specified herein before. Fan sheave shall have a tapered lock, split and keyed hub. Grove spacing on equipment and motor pulleys shall align. For fans 1/2 HP and larger, quantity of belts shall be such that if any one belt fails, remaining belts shall allow fan to continue functioning as designed. Multiple belts shall be provided as a matched set.
2. Motors shall meet requirements as specified in Motors section.
3. Motor shall be 1800 rpm maximum for belt driven or direct drive fans.
4. On OSHA approved type fan drive guard shall be provided with provision for RPM measurement at both motor and fan without removing the guard. The guard shall be made of 1/2 in., 16 gauge flattened expanded steel, wrapped around a 16 gauge channel frame suitably braced to prevent vibration. Guard shall be G-90 galvanized, or painted to match fan housing paint.
5. Fan belts shall be oil resistant 24,000-hour non-static belts.

X. Provide thrust arrestors as required to limit movement of the fan upon start-up.

Y. Provide riveted, engraved aluminum nameplate containing pertinent, specific fan data, including manufacturer, model, serial number, and electrical data, etc.

2.3 CENTRIFUGAL FANS

A. General:

1. Centrifugal type fans shall be belt drive, unless noted otherwise
2. Fans shall be backwardly inclined, airfoil, or flat blade type with a minimum of 9 blades.
3. Fans shall have sharply rising pressure characteristics at the operating point specified and shall be quiet and stable in operation. Horsepower characteristics shall be self-limiting (non-overloading) and at peak value at the specified operating point.
4. Each fan base shall be fully assembled with motor and drive on a structural steel base.

B. Fan Housing:

1. Fans having wheel diameters 36 in. and larger shall have horizontally flanged split housings as required for installation.
2. Fan housing and inlet shall be constructed to allow the fan wheel(s) to be removed through the inlet opening when the inlet cone is removed.
3. Provide a quick opening inspection door with heavy duty latches.
4. A 1/2 in. NPT tapped 3/4 in. diameter pipe coupling drain connection shall be welded to the fan scroll at the lowest point, equipped with a pipe plug.
5. Class I and II fans shall be convertible to a minimum of 8 standard discharge arrangements.
6. Provide a Fan cut-off to deliver good pressure distribution.

C. Fan Inlet and Wheel Cone:

1. Provide a precision die-spun or formed, and matched inlet and wheel cones for streamlined airflow into the wheel to ensure full loading of the blades.
2. Inlet and wheel cones shall be hyperbolic. Radial side sheets are not acceptable.
3. Inlet cone shall be heavy gauge, bolted to fan housing to allow for removal.
4. Fans that are not duct-connected shall be provided with inlet/outlet screen(s). Screen(s) shall be standard manufacturer provided screen or galvanized maximum nominal 1 in. by 1 in. mesh fabricated 10 gauge steel.
5. Hubs shall be straight bored or use taper lock bushings, keyed and set screwed to shaft for positive attachment. Hubs shall be securely riveted or bolted to the backplate or center plate. Bushed hubs are not acceptable.
6. Double-width double-inlet fans shall be a single wheel of the common center plate design or 2 single-width single-inlet wheels back-to-back, each keyed and set screwed to a common shaft.
7. Fan blades shall be continuously welded to the inlet hub and the backplate.
8. Wheel center plate or backplate shall be heavy gauge steel construction with a minimum gauge as indicated in material construction schedule.

D. Domed Roof:

1. General:

a. Housing shall be constructed of heavy gauge spun aluminum with a rigid internal support structure.
b. Fan wheel shall be backward inclined.
c. Drive frame assembly shall be constructed of heavy gauge steel.
d. Motors and drives shall be mounted on vibration isolators, out of the air stream.
e. Fresh air for motor cooling shall be drawn into the motor through a tube free or contaminants or through a space between the fan shroud and the motor cover.
f. Fan drives shall be sized for 1.5 times the motor horsepower. Pulleys shall be cast type, keyed and securely attached to the wheel and motor shafts.
g. Motor pulleys shall be adjustable for final balancing.

h. Provide a factory-installed disconnect switch, wired from the fan motor to a junction box installed within the motor compartment. Provide a conduit chase through the base to the motor compartment.
i. When backdraft dampers are installed below fan, provide a heavy gauge hinge kit to allow entire fan to tilt away from roof curb for access to dampers. Construct hinge kit with aluminum hinges and hold open cables for field installation.

2. Roof-mounted up blast exhaust fans shall have a leak proof housing constructed with a one-piece windband with an integral rolled bead, and shall be joined to the curb-cap with a continuously welded seam.
3. Sidewall mounted exhaust fans shall have a leak proof housing constructed with a one-piece windband with an integral rolled bead. Provide a mounting plate that will be attached and sealed to the wall prior to installing fan.

2.4 SOURCE QUALITY CONTROL

A. Run test all fans 1 HP and larger at the factory before shipment. Testing shall be conducted at the maximum fan class speed.

B. Statically and dynamically balance each fan per AMCA procedures. Perform electronic vibration analysis at the maximum fan class speed for all fans over 5 HP.

C. Unless noted otherwise, the installed maximum allowable RMS velocity at maximum fan class speed measured at each bearing shall not exceed 0.09 inches/sec in vertical, horizontal, and axial directions.

D. Fans may be field tested after installation by an independent third party. Any fan found to exceed specified vibration limits shall be corrected to perform within those limits without cost to the Owner.

PART 3 - INSTALLATION

3.1 FAN INSTALLATION

A. Coordinate the fan arrangement with project conditions prior to ordering the fan.

B. Receive and inspect fans for defects. All defective or damaged fans shall be replaced at no cost to the Owner.

C. Openings shall remain protected during storage. Immediately after installation and assembly, all factory protection shall be restored. Unit shall remain protected until just prior to final acceptance by Owner.

D. Use spreader bars on lifting cables when hoisting fans from lifting lugs to prevent cable damage to housing or components. Rig fans per fan manufacturer's recommendations.

E. Fans shall be installed as shown on drawings, in accordance with details, approved submittals and the fan Manufacturer's installation requirements and recommendations. Ensure fans are installed to allow easy accessibility for service or removal of fan components.

F. Provide and install supplemental steel, supports, isolators and hangers necessary to hang or mount fans. Coordinate final location and placement of intermediate steel and ductwork connections in field. Install suspended fans with supports attached to structural members.

G. Install any associated motors, drives, or other components that have been shipped loose. Fan shall be installed, made fully operation, and tested.

H. Install flexible inlet and discharge couplings to prevent vibration transmission to ductwork.

I. Inlet and discharge ductwork shall have a minimum straight run of two (2) fan diameters upstream and downstream of the fan.

J. Just prior to final acceptance fan shall be thoroughly cleaned of all grease, dirt, and dust, etc. Apply touch-up paint or touch-up coating after final cleaning to repair any damage to the finish.

K. Provide or coordinate the scope of work associated with the installation of fans as specified in the following sections:

1. Roof curbs
2. Vibration isolation
3. Sheet Metal accessories
4. Interconnection wiring and conduit from power source to fan connection (starter).

L. Perform the following tests and inspections prior to fan operation:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices, and that connections to ducts and electrical components are complete.
3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. Inspect fan scroll for debris or water.
6. Remove guards. Align and adjust belt tension, verify that fan wheel and motor rotate freely, and that bearing operation is smooth. Re-install belt guards.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication of bearings and other moving parts. Use proper bearing venting procedures, in particular at motor bearings. Use only grease type specifically recommended by fan mfr. Do not over-grease. Fill extended grease lines if not already filled, using mfr. recommended grease and proper venting procedures.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Verify proper motor and fan rotation.
11. Remove and replace malfunctioning units and retest as specified above.

3.2 FIELD QUALITY CONTROL

A. Each fan shall be field tested. Any deficiencies related to performance, manufacture or installation shall be corrected without cost to Owner.

END OF SECTION 23 3400

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.3 SUBMITTALS

A. Product Data: For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: Of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Sections.

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Diffusers, registers, and grilles are scheduled at the end of this Section.

B. Diffusers, registers, and grilles are scheduled on Drawings.

2.2 SOURCE QUALITY CONTROL

A. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

2.3 DIFFUSERS

A. Manufacturers:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Air Systems Components; Krueger Div.
   b. Price.
   c. Nailor Industries Inc.
   d. Titus.

2. Accessories: Include the following:

   a. Equalizer deflectors.
   b. Smudge ring.
   c. Plaster ring.
   d. Extractor.
   e. Blank-off panel.
   f. Operating keys.

2.4 REGISTERS

A. Manufacturers:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Air Systems Components; Krueger Div.
   b. Price.
   c. Nailor Industries Inc.
   d. Titus.

2. Accessories: Include plaster frame.

2.5 GRILLES

A. Manufacturers:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Air Systems Components; Krueger Div.
   b. Price.
   c. Nailor Industries Inc.
   d. Titus.

2. Accessories: Include plaster frame.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the grid. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 23 3713

SECTION 23 4000 - AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.2 REFERENCED CODES AND STANDARDS

A. The following codes and standards are referenced through out. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.

1. ASHRAE Standards 62 & 52
2. National Electric Code NFPA 70
3. UL 867 including ozone chamber test required as of December 21, 2007

1.3 QUALITY AND IP ASSURANCE

A. The Air Purification System shall be a product of an established manufacturer within the USA.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.

D. Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation performed within the last two years and in a similar application, that proves compliance to ASHRAE 62 and the accuracy of the calculations.

E. The Air Purification System shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested in accordance with the newest UL 867 standard with the ozone amendment shall not be acceptable. All manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

F. The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.007 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the electronic air cleaner's output shall be no more than 0.0042 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for ion generators including:

1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
3. Performance data for each type of plasma device furnished.
4. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled (when projects are designed with outside air reduction).
5. Product drawings detailing all physical, electrical and control requirements.
6. Copy of UL 867 independent ozone test.

B. Operating and Maintenance Data: Submit O&M data and recommended spare parts lists.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.

B. Store in original cartons and protect from weather and construction work traffic.

C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.6 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of eighteen months after shipment or twelve months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.1 BI-POLAR IONIZATION DESIGN AND PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

B. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure and furnishings.
3. Capable of reducing static space charges.
4. Increasing the interior ion levels, both positive and negative, to a minimum of 800 ions/cm³ measured 5 feet from the floor.
5. Self-cleaning requiring no maintenance or replacement parts.
6. Producing a minimum of 200M ions/cc.

C. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.

1. Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
2. Velocity Profile: The air purification device shall not have maximum velocity profile.

D. Humidity: Plasma generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

E. Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

a. Each plasma generator with bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of one electrode pair per 4,800 CFM of air flow shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.
b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating. Electrodes shall be made from carbon fiber to prevent oxidation over time. Internal circuitry shall be provided to sense air flow across the electrode output. Ionization systems requiring the use of a mechanical air pressure switch to cycle the electrodes only when the fan is operating shall not be acceptable due to high failure rates and pressure sensitivity.
c. Electrode pair shall provide a minimum of 200 million ions per cubic centimeter as measured at 2 inches, both positive and negative ions, in equal quantities. Devices providing less than 200 million ions/cc per electrode pair shall not be acceptable.
d. Each plasma generator shall be provided with a self-cleaning system that is field programmable to change the number of days between the cleaning cycle. Systems without a no-maintenance, self-cleaning system shall not be acceptable.
e. Each electrode pair shall be designed with a banana style plug such that it can be field replaced if necessary.
f. Each plasma generator shall be provided with an inline on/off switch, universal voltage input (24VAC to 240VAC or DC), magnets for mounting to the fan inlet, replaceable carbon fiber emitters and a programmable self-cleaning system.

F. Air Handler and Plenum Mounted Units (non-ductless mini-split units):

1. Where so indicated on the plans and/or schedules plasma henerator(s) shall be supplied and installed. The mechanical contractor shall mount the plasma generator and wire it to the AHU control power (24VAC) as instructed by the air purification manufacturer's instructions or line voltage subject to power available. Each unit shall be designed with a molded casing, self-cleaning system, self-cleaning test button, power status LED and dry contacts to prove ion output is operating properly. The dry contacts shall close to prove the ion generator is working properly and may be daisy chained in series such that only one dry contact per AHU is required to interface to the BAS or the optional DDC controller. Dry contacts proving power has been applied in lieu of the ion output is actually operating, are not acceptable. Manufacturers providing multiple ion modules that have alarm status wired in parallel, and not in series, shall not be acceptable.

G. Ionization Requirements:

1. Plasma generators with bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.

   a. The bi-polar ionization system shall consist of bi-Polar plasma generator and integral power supply. The bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 24VAC to 240VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
   b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.
   c. Ionization output from each electrode shall be a minimum of 200 million ions/cc when tested at 2" from the ionization generator.
   d. All manufacturers shall provide documentation by an independent NELAC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

      1) MRSA - >96% in 30 minutes or less
      2) E.coli - > 99% in 15 minutes or less
      3) TB - > 69% in 60 minutes or less
      4) C. diff - >86% in 30 minutes or less

   e. Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C. Products tested only on Petri dishes to prove kill rates shall not be acceptable.

2. Ozone Generation:

   a. The operation of the electrodes or bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no ozone generation during any operating condition, with or without airflow.

H. Electrical Requirements:

1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma generator shall accept an electrical service of 24VAC to 240VAC, universal 2 wire input, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.

I. Control Requirements:

1. All plasma generators shall have internal short circuit protection, overload protection, and automatic fault reset circuit breakers. Systems with manual fuses shall not be allowed.
2. Integral airflow sensing shall modulate the plasma output as the airflow varies or stops. A mechanical airflow switch shall not be acceptable as a means to activate the plasma device due to high failure rates and possible pressure reversal.
3. The installing contractor shall mount and wire the plasma device within the air handling unit specified or as shown or the plans. The contractor shall follow all manufacturer IOM instructions during installation.
4. All plasma devices shall have a means to interface with the BAS system. Dry contacts shall be provided to prove there are ions being produced. Systems providing indication that power is applied to the plasma device, but not directly sensing the power at the ion output, shall not be acceptable.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY AND ERECTION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.

B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.

C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.3 TESTING

A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING AND TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION 23 4000

SECTION 23 6313 - AIR-COOLED CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, air-cooled condensing units that contain condenser coils and fans housed in a weatherproof casing for outdoor installation.

1.2 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For each air-cooled condenser to include in the maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

A. Listing and Labeling: Provide equipment and accessories specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NFPA 70.

C. Condensing unit rated in accordance with AHRI Standard 365.

1.4 COORDINATION

A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Section 03300 "Cast-in-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Section 07720 "Roof Accessories."

C. Coordinate locations for refrigerant piping and electrical rough-ins.

D. Coordinate system controls requirements accordingly. Unit supplier/manufacturer shall review the corresponding unit Control Diagram and Sequence of Operations included in the project drawing set. Supplier/manufacturer shall coordinate as necessary and shall provide the unit with all equipment, options, and features as necessary to provide the intended system operational control. Any discovered discrepancies shall be identified to the Project Manager via RFI prior to bid. Supplier/manufacturer shall coordinate with the Controls Contractor as necessary to provide a complete controls solution as indicated in the project documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide air-cooled condensers by one of the following:

1. Carrier Corporation; Carrier Air Conditioning Division
2. Lennox International, Inc.; Lennox Industries, Inc.
3. York International Corporation
4. Daikin Applied
5. Aaon.

2.2 MANUFACTURED UNITS

A. General Description:

1. The complete unit shall be ETL listed.
2. Unit shall be completely factory assembled and shipped in one piece.
3. Unit to be shipped with a nitrogen holding charge only.
4. The unit shall undergo an operational test prior to shipment. The factory test shall include a refrigeration circuit check test, a unit safety control system operations checkout, and a final unit inspection.
5. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
6. Performance: All scheduled capacities and face areas are the minimum accepted value. All scheduled amps, KW, and HP are maximum accepted values that allow scheduled capacity to be met.

B. Cabinet:

1. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16” at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
2. The unit base frame shall be constructed of 13 gauge pre-painted galvanized steel.
3. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

C. Electrical:

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be number and color coded and labeled according to the electrical diagram provided for easy identification.
2. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch circuit short circuit protection, 115 volt control circuit transformer and fuse, system switches, and a high temperature sensor. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Knockouts shall be provided in the side of the main control panels for field wiring entrance.
3. All 115-600 volt internal and external wiring between control boxes and components shall be protected from damage by raceways or liquid tight conduit.

4. The receptacle shall be powered by a field supplied 115V source.
5. Single non-fused disconnect swtich shall be provided for connecting electrical power at the unit. Disconnect switches shall be mounted internal to the control panel and operated by an externally mounted handle. Externally mounted handle is designed to prohibit opening of the control panel door without the use of a service tool.
6. Unit SCCR rating to be 65 kAIC.
7. Phase failure and under voltage protection shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.
8. Unit shall be provided with a 24 volt transformer and terminal strip for field supplied controls.

D. Condensing Section:

1. Air Cooled Condenser:

a. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
b. Units shall have low ambient cooling operation down to 0F. Variable speed condenser fan on each circuit to control head pressure.

2. Refrigeration Circuit:

a. Dual Circuit Refrigeration
b. Refrigeration capacity control shall be accomplished by the modulation of the digital scroll compressor (1-5 VDC signal) and staging of fixed compressor(s). Unit shall be equipped with a 24V terminal strip for field supplied and installed controls.

3. Hot Gas Reheat Circuit (where scheduled):

a. One circuit off the condensing unit shall be used for hot gas reheat at AHU-6. Factory installed modulating HGRH valve at condensing unit. Terminal board at condensing unit provided to accept 0-10VDC signal to modulate hot gas reheat capacity.

E. Controls:

1. Refrigeration capacity control shall be accomplished by the modulation of the digital scroll compressor (1-5 VDC signal) and staging of fixed compressor(s). Unit shall be equipped with a 24V terminal strip for field supplied and installed controls. Temperature controls by TCC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air-cooled condensers according to manufacturer's written instructions.

B. Install units level and plumb, according to manufacturer's written instructions, Shop Drawings, original design, and referenced standards.

C. Install roof-mounted units on equipment supports. Anchor unit to supports with removable fasteners.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Refrigerant Piping: Comply with applicable requirements of "Refrigerant Piping." Connect piping to unit with pressure relief, service valve, filter dryer, and moisture indicator on each refrigerant-circuit liquid line.

C. Electrical: Comply with applicable requirements in Division 23.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant and oil.

B. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units with new units and retest.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean to remove burrs and construction debris and repair damaged finishes.

3.5 COMMISSIONING

A. Verify that units are installed and connected according to the Contract Documents.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for physical damage to unit casing.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Check that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

C. Lubricate bearings on fans.

D. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

E. Adjust fan belts to proper alignment and tension.

F. Start unit according to manufacturer's written instructions.

1. Complete manufacturer's starting checklist.

G. Measure and record airflow over coils.

H. Check operation of low ambient control device.

I. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

J. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals. Refer to "Closeout Procedures".
3. Review data in the maintenance manuals. Refer to "Operation and Maintenance Data".
4. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 23 6313

SECTION 23 7313 - MODULAR INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes constant-volume, modular air-handling units with coils for indoor installations.

1.3 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated
2. Certified fan-sound power ratings
3. Certified coil-performance ratings with system operating conditions indicated
4. Motor ratings, electrical characteristics, and motor and fan accessories
5. Material gages and finishes
6. Filters with performance characteristics
7. Dampers, including housings, linkages, and operators

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that modular indoor air-handling units, accessories, and components will withstand seismic forces defined in Section 15071 "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated. Refer to Section 01600 "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

E. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

F. Comply with NFPA 70.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at ± 8 inch wg.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate size and location of structural-steel support members.

C. Coordinate system controls requirements accordingly. Unit supplier/manufacturer shall review the corresponding unit Control Diagram and Sequence of Operations included in the project drawing set. Supplier/manufacturer shall coordinate as necessary and shall provide the unit with all equipment, options, and features as necessary to provide the intended system operational control. Any discovered discrepancies shall be identified to the Project Manager via RFI prior to bid. Supplier/manufacturer shall coordinate with the Controls Contractor as necessary to provide a complete controls solution as indicated in the project documents.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each modular indoor air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Buffalo Air Handling
2. Carrier; Division of United Technologies Corporation
3. CES Group Inc.; Governair, Mammoth, Temtrol, Venmar Ventrol, Webco Divisions
4. York International Corporation
5. AAON
6. Daikin Applied

2.2 MANUFACTURED UNITS

A. Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and accessories.

2.3 UNIT CASINGS

A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.

B. Base Rail:

1. Height: 8 inches150 mm or as required to achieve the full coil trap height above the mechanical room floor.

C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.

D. Double-Wall Construction:

1. Outside Casing Wall:

a. Material, Galvanized Steel: Minimum 18 gauge1.3 mm thick.
b. Factory Finish: Provide manufacturer's standard finish.

2. Inside Casing Wall:

a. Material, Galvanized Steel: Solid, minimum 18 gauge1.3 mm thick.

E. Floor Plate:

1. Material, Galvanized Steel: Match Inside Casing Material, minimum 18 gauge1.3 mm thick.

F. Casing Insulation:

1. Materials: Injected polyurethane foam insulation.
2. Casing Panel R-Value: Minimum R-13.
3. Insulation Thickness: 2 inches50 mm.
4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

G. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

H. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 8-inch wg1500 Pa.
2. For Unit Sections Downstream and Including Fans: 8-inch wg1500 Pa.

I. Knock-Down Shipment

1. AHU shall ship knocked down, palletized per section, with labels on all components and reassembly instructions.
2. AHU manufacturer shall provide supervision support during reassembly for installing contractor.

J. Panels, Doors, and Windows:

1. Panels:

a. Typically used for coil replacement access.
b. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
c. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
d. Gasket: Neoprene, applied around entire perimeters of panel frames.
e. Size: Refer to AHU detail drawings.

2. Doors:

a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Refer to AHU detail drawings.

3. Windows:

a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
b. Size: Minimum 6 inches150 mm, square or round.
c. Windows should be located within doors for the easiest viewing at a standard 6 foot height above finished floor. This means view port windows on doors in the upper air tunnel need to be installed towards the bottom of the access door.

K. Condensate Drain Pans:

1. Construction:

a. Stainless-steel with foam insulation underneath and moisture-tight seal.

2. Drain Connection:

a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
b. Minimum Connection Size: NPS 2DN 50.

3. Slope: Minimum 0.125-in./ft.10-mm/mm slope, to comply with ASHRAE 62.1,in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
4. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
5. Width: Entire width of water producing device.
6. Depth: A minimum of 2 inches50 mm deep.
7. Formed sections.
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FAN, DRIVE, AND MOTOR SECTION

A. Provide direct-drive airfoil plenum supply fan array. Fan assemblies including individual fans and motors within the array shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

1. The fan array shall be arranged with high performance direct drive, single inlet, plenum fans with backwards inclined, high efficiency welded-aluminum or high-performance composite impeller with galvanized or aluminum support frame.
2. Manual blank-off plates shall be provided to block fan airflow, one plate to be provided per array.
3. The fans shall be driven by long-life, low-temperature brushless DC electronically commutated motor (EC-Motor) with external rotor and integrated maintenance-free electronic circuitry and electronics. The motor is manufactured with maintenance-free, permanently lubricated ball bearings and shall be statically and dynamically balanced in accordance with ISO 1940 part 1. The motor shall be closed, protection level IP 54, thermal class 155 with permissible operating temperature of -13°F to 140°F. Motor efficiency class shall comply with IE4. Fan characteristic curves indicate measurements on a chamber test in accordance with ISO5801. The three-phase external rotor motor integrated into the fan hub meets the requirements for circulating electric machines set forth in DIN EN 60 034-1 (VDE 0530 Part 1).

    a. The fan array shall be listed per UL 1995.
    b. The fan assembly shall be prewired with wire whips and plug connectors.

4. The fan bulkhead wall shall be constructed in a manner for easy field assembly, constructed of 14 gauge G90 formed sheet metal. The bend profile at each panel seam shall provide vertical structural support for the bulkhead wall.
5. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.
6. The fan array shall include a packaged control panel mounted on the outside face of the air handling unit.

    a. The control panel shall include an external disconnect and shall be UL or ETL listed.
    b. The panel contains a lockable Hand/Off/ Auto switch for optional manual speed control.
    c. The panel accepts a 0-10VDC signal when in Auto mode and can be controlled locally when in Hand Mode.
    d. The panel shall be provided with a BACnet compatible controller capable of monitoring the arrays airflow, total static pressure, power consumption, RPM, and individual fan alarm status and specific cause of alarm. Controller shall be configurable for fan speed control via BACnet interface (MS/TP), 0-10 VDC input, 4-20 mA input, constant airflow, or duct static pressure (static pressure sensor to be field provided and mounted).
    e. The panel shall be equipped with relays for locking between other electrically driven components.
    f. There is a system alarm contact that the BAS can use to check the status of the fan array system. There is a system enable contact that the BAS can use to enable or disable the fan array system, along with a safety circuit terminations.

7. All fan components shall be sized to fit through a 20 x 40 access opening.
8. Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field.

2.5 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.

2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Heating Coils:

1. Hot-Water Coils: Continuous circuit.

a. Water coils certified in accordance with AHRI Standard 410 and bearing the AHRI label. Manufacturer ISO 9002 certified.
b. Piping Connections: Threaded, same end of coil.
c. Tube Material: Copper.
d. Fin Type: Plate.
e. Fin Material: Aluminum.
f. Fin Spacing: Maximum 10 fins per inchmm.
g. Tube Thickness: 0.025 inchesmm.
h. Fin and Tube Joint: Mechanical bond.
i. Headers:

1) Cast iron with cleaning plugs and drain and air vent tappings extended to exterior of unit.
2) Seamless copper tube with brazed joints, prime coated.
3) Fabricated steel, with brazed joints, prime coated.
4) Provide insulated cover to conceal exposed outside casings of headers.

j. Frames: Channel frame, 0.079-inch-2.0-mm- thick, galvanized steel.
k. Coil Working-Pressure Ratings: 200 psig1380 kPa, 325 deg F (163 deg C).
l. Coating: None.

C. Cooling Coils:

1. DX Coil: Inter

a. Water coils certified in accordance with AHRI Standard 410 and bearing the AHRI label. Manufacturer ISO 9002 certified.
b. Piping Connections: Threaded, same end of coil.
c. Tube Material: Copper.
d. Tube Thickness: Insert value 0.020 inchesmm.
e. Fin Type: Plate.
f. Fin Material: Aluminum.
g. Fin Spacing: Maximum 10 fins per inch unless specifically scheduled otherwise.
h. Headers:

1) Cast iron with cleaning plugs and drain and air vent tappings[extended to exterior of unit].
2) Seamless copper tube with brazed joints, prime coated.
3) Fabricated steel, with brazed joints, prime coated.
4) Provide insulated cover to conceal exposed outside casings of headers.

i. Frames: Channel frame, galvanized steel.
j. Coatings: None.
k. Working-Pressure Ratings: 250 psig1380 kPa(163 deg C).

D. Hot Gas Reheat Coil:

1. Provide microchannel, aluminum, type hot gas reheat coil.

2.6 AIR FILTRATION SECTION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

B. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

2.7 MATERIALS

A. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

B. Galvanized Steel: ASTM A653/A653M.

C. Aluminum: ASTM B 09ASTM B209M.

2.8 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.

C. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

D. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

E. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

F. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

G. Water Coils: Factory tested to 300 psig2070 kPa according to AHRI 410 and ASHRAE 33.

H. Witnessed Casing Leakage Tests:

1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

2.9 DAMPERS

A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2,000 fpm face velocity through damper and 4 inch wg pressure differential.

B. Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1 inch wg and 9 cfm/sq. ft. at 4 inch wg.

C. Mixing Boxes: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

D. Combination Filter and Mixing Box: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2 inch thick, pleated, flat permanent or throwaway filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4DN 32, ASTM B88, Type M (ASTM B88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch13 mm high.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units.

END OF SECTION 23 7313

SECTION 23 7315 - PACKAGED AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes constant-volume, modular air-handling units with coils for indoor installations.

1.3 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated
2. Certified fan-sound power ratings
3. Certified coil-performance ratings with system operating conditions indicated
4. Motor ratings, electrical characteristics, and motor and fan accessories
5. Material gages and finishes
6. Filters with performance characteristics
7. Dampers, including housings, linkages, and operators

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated. Refer to Section 01600 "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

E. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

F. Comply with NFPA 70.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at ± 8 inch wg.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate size and location of structural-steel support members.

C. Coordinate system controls requirements accordingly. Unit supplier/manufacturer shall review the corresponding unit Control Diagram and Sequence of Operations included in the project drawing set. Supplier/manufacturer shall coordinate as necessary and shall provide the unit with all equipment, options, and features as necessary to provide the intended system operational control. Any discovered discrepancies shall be identified to the Project Manager via RFI prior to bid. Supplier/manufacturer shall coordinate with the Controls Contractor as necessary to provide a complete controls solution as indicated in the project documents.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each modular indoor air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Buffalo Air Handling
2. Carrier; Division of United Technologies Corporation
3. CES Group Inc.; Governair, Mammoth, Temtrol, Venmar Ventrol, Webco Divisions
4. York International Corporation
5. AAON
6. Daikin Applied

2.2 AIR HANDLER TYPE AND ARRANGEMENT

A. The air handler shall be furnished as a horizontal draw-through cooling coil and heating coil in reheat position only type. Provide needle point ionization – refer to specification 23 4000 “Air Purification”.

2.3 AIR HANDLER CASING

A. Air handler casing shall be constructed with a corrosion resistant aluminum frame with 1” thick, double wall panels. Extruded aluminum frame and polymeric corner pieces are required for casing protection and rigidity. Unit panels shall consist of injected polyurethane foam insulation sandwiched between galvanized steel exterior and interior sheets. Formed “thermal break” panels shall have a plastic molded edge to eliminate inner and outer panels from contacting each other.

1. Panels shall be fastened to frame with perimeter screws with a neoprene gasket in-between the panel and the frame to minimize air leakage and prevent thermal bridging from unit interior to unit exterior. Hinged and latched access panels for blower and filter sections shall be furnished on both the drive & opposite drive side to allow access to unit interior. Blower panel shall be furnished two, quarter-turn open-to-close, latch assemblies, one tooled flathead screw type and one with lever

handle operation. Filter access panels shall be provided with hinges and two, quarter-turn open-to-close latch assemblies on the drive & opposite side only.

2.4 SUPPLY FAN

A. The supply fan shall be a SWSI direct-drive backward-inclined plenum fan type. Fan assembly including fan and motor shall be dynamically balanced by the manufacturer on all three planes. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fan variable frequency drive shall control the fan speed from a minimum of 20Hz and shall not exceed 90Hz.

B. Fan and motor assembly shall be mounted on vibration type isolators inside cabinetry.

2.5 BEARINGS AND DRIVES

A. Basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.

B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

C. V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves selected so required RPM is obtained with sheaves set at mid-position and rated based on motor horsepower. Contractor to furnish fixed sheaves at final RPM as determined by balancing contractor.

2.6 ELECTRICAL

A. Motor shall be a premium efficiency open drip-proof type. Electrical characteristics shall be as shown on the schedule.

B. A variable frequency drive with fused disconnect switch shall be furnished and mounted by fan manufacturer for field power connection.

2.7 COOLING AND HEATING SECTIONS

A. Access to coils from drive side [opposite connection side] of unit for service and cleaning shall be provided. Coil headers and return bends shall be fully enclosed within unit casing. Coil connections shall be factory sealed with grommet on exterior and gasket sleeve between outer wall and inner liner where each pipe extends through the unit casing to minimize air and condensate leakage.

B. Cooling Coils.

1. Refrigerant coils shall be designed for use with refrigerant as specified on the unit schedule. Fins shall have a minimum thickness of .006 inches aluminum with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tube shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
2. Refrigerant coil suction connection shall be constructed of copper sweat type and shall be located at the bottom of the suction headers for gravity oil drainage. Pressure type liquid distributors shall be furnished. Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure. Coils shall be ARI certified and Underwriters Laboratories, Inc. listed.
3. Drainpan shall be constructed from stainless steel, pitched and sloped in direction of airflow to drain connection to allow for condensate drainage. Drainpan shall be positioned above 1” thick insulated double wall panel. Condensate drain connections shall be provided on both sides of drain pan. Secondary drain connection shall be provided.
4. Coil casing shall be constructed of Galvanized steel.

C. Water Heating Coil.

1. Hot water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
2. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be carbon steel connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.
3. Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point.

2.8 FILTER SECTION

A. Filter section shall be a 4-inch deep flat type furnished with MERV 14 deep pleated type filter.

B. Filter media shall be UL 900 listed, Class I or Class II.

2.9 MIXING BOX

A. Mixing box shall be constructed as described in section titled AIR HANDLER CASING. The mixing box return and outside air openings shall be located as specified on plans and schedule.

1. The outside air mixing box dampers shall be constructed of airfoil design extruded aluminum blades and aluminum frame.
2. The return air mixing box dampers shall be constructed of airfoil design extruded aluminum blades and aluminum frame.
3. A damper actuator shall be furnished and mounted by others.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4DN 32, ASTM B88, Type M (ASTM B88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch13 mm high.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units.

END OF SECTION 23 7315

SECTION 26 0500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

B. This Section shall apply to all Division 26 Sections and to the following Division 28 Sections: fire alarm systems, mass notification systems, and emergency response systems.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01 Sections.

1. Codes and standards
2. Quality assurance
3. Examination of drawings and premises
4. Substitutions
5. Alternates
6. Permits, fees, and inspections
7. Changes involving Electrical Work
8. Submittals
9. Project record documents
10. Delivery, storage, and handling
11. Warranty
12. Scope of work specified in Division 26 and Division 28 sections
13. Related work specified in other Divisions
14. Systems provided by Owner

B. Part II – Products:

1. This Section includes basic requirements for materials and installations for electrical work, including but not limited to:

a. Concrete
b. Access doors
c. Sealing of openings
d. Sleeves
e. Expansion fittings
f. Framed one-line diagram

C. Part III – Execution:

1. This section includes basic requirements for installations for electrical work.

a. Electrical demolition work
b. Temporary services
c. Cutting and patching
d. Chases and recesses
e. Excavation and backfill
f. Equipment foundations and supports
g. Coordination with other trades
h. Assembly and connection of equipment
i. Field quality control

1.3 CODES AND STANDARDS

A. The electrical characteristics, physical properties, design, performance characteristics, methods of construction, all material, and the installation techniques shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. ADA – Americans with Disabilities Act
2. AEIC – Association of Edison Illuminating Companies
3. ANSI – American National Standards Institute
4. ASTM – ASTM International, formerly known as American Society for Testing and Materials
5. BICSI – Building Industry Consulting Service International
6. FCC – Federal Communications Commission
7. ICEA – Insulated Cable Engineers Association
8. IEC – International Electrotechnical Commission
9. IEEE – Institute of Electrical and Electronics Engineers
10. MBC – Michigan Building Code
11. MIOSHA – Michigan Occupational Safety and Health Administration
12. NEC – National Electrical Code
13. NETA – InterNational Electrical Testing Association
14. NEMA – National Electrical Manufacturers Association
15. NFPA – National Fire Protection Association
16. OSHA – Occupational Safety and Health Administration
17. UL – UL, LLC, formerly known as Underwriters Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. Furnish all labor, materials, equipment, technical supervision, and incidental services required to complete, test, and leave ready for operation the electrical systems as specified in the Division 26 Sections, Division 28 Sections that this section applies to per paragraph 1.1 Related Documents, and as indicated on Drawings.

1. The Electrical Drawings indicate the general design and extent of the electrical system. Comply with the Drawings as closely as actual construction of the building and the work of other Trades permit.

B. Perform all work in a first class and workmanlike manner in accordance with the latest accepted standards and practices for the Trades involved.

1. All equipment of the same or similar systems shall be by the same manufacturer.

C. Regulatory Requirements:

1. Codes, Standards, Ordinances, and Regulations: Perform all work in accordance with applicable Federal, State, and local ordinances and regulations. Perform all work to comply with Codes and Standards identified in these Specifications.

    a. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to comply with the above codes, standards, ordinances, and regulations. After entering into a contract, make all changes required to comply with the above codes, standards, ordinances, and regulations without additional expense to the Owner.
    b. Barrier-Free Regulations: All materials and installations shall comply with the requirements of the State of Michigan Barrier-Free Regulations and with the Americans with Disabilities Act (ADA).

D. Field Measurements:

1. Drawings are not intended to be scaled for roughing-in or to serve as shop drawings. Take all field measurements required for fitting the installation to the building.

E. Sequencing and Scheduling: Sequence and schedule work in order to avoid interference with the work of other Trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

1.5 EXAMINATION OF DRAWINGS AND PREMISES

A. Before submitting the Bid, examine the Architectural, Mechanical, and other Trades' Drawings and Specifications.

1. Notify the Architect/Engineer should any discrepancies occur between the other Trades and the electrical work.
2. No additional charges will be allowed because of failure to make this examination or to include all materials and labor required for the electrical work specified in other Trades' documents.
3. The Architectural Drawings take precedence in all matters pertaining to the building structure, the Mechanical Drawings take precedence in all matters pertaining to the Mechanical Trades, and the Electrical Drawings take precedence in all matters pertaining to the Electrical Trades. However, where there are conflicts or differences between the Drawings for the various Trades, report such conflicts or differences to the Architect/Engineer who shall determine the course of action to be taken.

B. Before submitting the Bid, examine the premises to determine existing conditions for performing the electrical work.

1. Notify the Architect/Engineer should any discrepancies occur between the existing conditions and the electrical work.
2. No additional charges will be allowed because of failure to make this examination or to include all materials and labor required to complete the electrical work.

1.6 SUBSTITUTIONS

A. Base Bid shall be in accordance with materials and products specified. Any exceptions to this shall be approved in writing by the Architect/Engineer ten (10) days or more prior to bidding.

1.7 ALTERNATES

A. Mandatory Alternates:

1. The Contractor shall refer to Alternates listed in Division 01 and Proposals and shall submit price quotations for the alternates that apply to the electrical work.

B. Voluntary Alternates:

1. Voluntary alternates may be submitted for consideration with listed addition or deduction to the Bid but will not affect the awarding of the Contract.

1.8 PERMITS, FEES, AND INSPECTIONS

A. Obtain all permits, licenses, inspections, and tests required. At the completion of the work, obtain and send certificates of inspections and approvals to the Architect/Engineer.

1. Pay all fees and expenses for permits, licenses, tests, and inspections.
2. A copy of the final approved inspection certificates for electrical work specified in all Division 26 Sections and Division 28 Sections that this section applies to per paragraph 1.1 Related Documents shall be provided as a requirement prior to final payment.

1.9 CHANGES INVOLVING ELECTRICAL WORK

A. The design of the electrical systems is based on the mechanical and building equipment specified and scheduled on the Drawings.

1. Where equipment changes are made that involve additional electrical work (increased motor horsepower or increased unit full load amperes, requirements for a disconnect switch scheduled to be part of the equipment, requirements for a starter scheduled to be part of the equipment, additional wiring of equipment, etc.) the Mechanical or respective Trades involved shall compensate the Electrical Trades for the cost of the additional work required.

1.10 SUBMITTALS

A. The following is in addition to the requirements for submittals in Division 01.

B. Material List: Submit a complete list of all materials and equipment indicating their manufacturer for approval by the Architect/Engineer within 15 days after award of contract and prior to submittal of shop drawings.

C. Construction Schedule: Submit a construction schedule including milestone dates and lead times for major electrical equipment.

D. Provide equipment submittals in the form of letters of intent, product data or, shop drawings as specified for all materials provided on the project.

E. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Provide a space approximately 4” x 5” on the label or beside the title block on shop drawings to record the review and approval markings and the action taken.
2. Include the following information on the label for processing and recording action taken.

a. Project Name
b. Date
c. Name and address of Architect/Engineer
d. Name and address of Contractor
e. Name and address of Subcontractor
f. Name and address of Supplier
g. Name of Manufacturer
h. Number and title of appropriate Specification Section
i. Drawing number, identification mark, fixture type, panelboard number, specification section number, and detail references, or as noted on the Electrical Drawings.

F. Equipment submittals shall be reviewed by the Electrical Contractor for completeness and accuracy and prior to submitting to the Architect/Engineer for review. Submittals shall be dated and signed by the Electrical Contractor. Note on the submittal any and all exceptions or changes to the Drawings and Specifications required by the submittal to meet the specified products.

G. Partial submittals for equipment shall not be permitted. Where partial submittals are transmitted to the Architect/Engineer, they will be returned "Rejected”.

H. Where the equipment submittals consist of manufacturer's standard detail drawings or schedules and contain data for a variety of similar equipment, indicate the data pertinent to the equipment furnished for this project only. Standard detail drawings and schedules not clearly indicating which data is associated with this Project shall be returned "Rejected".

I. Where accessories and/or options are specified and do not appear as part of manufacturer's standard detail drawings or schedules, state each accessory that is to be provided with the equipment on the standard detail drawings or schedules.

J. The letter of intent shall state that the product is exactly as specified with no exceptions and that the product is being manufactured by one of the specified manufacturers. The letter of intent shall include the specification section number, the product description, and the name of the selected manufacturer. The aforementioned information shall be typed on the Electrical Contractor's letterhead.

K. Lighting fixture submittals shall be submitted as one (1) package including all fixtures intended to be used for this Project.

L. CADD files of the Electrical Drawings will be provided by the Architect/Engineer for this Contractor's use in preparing submittals. Refer to Division 01 for the forms and procedures for requesting electronic files/media.

M. Layout Shop Drawings: Prepare layout shop drawings drawn to scale in electronic format and submit electronic copies in .PDF and .DWG formats to the Architect/Engineer for review. Refer to Division 01 for submittals and quantities.

1. Layout shop drawings shall show building floor plans to scale and shall include lighting and power distribution systems, all details of electrical construction, routing of conduits, wiring, circuiting, and related information necessary for the installation and future maintenance of the electrical wiring systems.

N. No apparatus or equipment shall be shipped from stock or fabricated until their equipment submittals have been reviewed and approved by the Architect/Engineer. By the review of submittals, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Electrical Trades of full responsibility for the proper and correct execution of the work required.

1.11 PROJECT RECORD DOCUMENTS

A. Submit final project record documents as described in Division 01.

B. As-Built Drawings: At the completion of the work, submit to the Architect/Engineer the revised set of drawings in electronic file format indicating all changes from the bid documents using redlines, bubbles, or another approved method. The Drawings shall contain all title block information as originally issued by the Architect/Engineer with the addition of the Electrical Contractor's company name, address, telephone number, company's project number, date of issuance by the Electrical Contractor, and issued for "As-Built" in title.

C. Operation and Maintenance Manuals: The manuals shall contain operating instructions, service instructions, parts lists, etc., which are shipped with electrical equipment. At the completion of the work, transmit these items to the Owner. If this information is not shipped with the equipment, obtain it from the manufacturer.

D. Maintenance Materials: Retain all portable and detachable portions of the installation such as keys, tools, manuals, etc., until the completion of the work and then transmit them to the Owner and obtain itemized receipt. This receipt shall be provided as a requirement prior to final payment.

E. Record Documents Manual: At the completion of the work, furnish and deliver to the Owner and Architect/Engineer two (2) electronic sets on USB flash drive of the record documents manual.

1. One (1) copy of all shop drawings and product data
2. One (1) copy of operation and maintenance manuals
3. One (1) copy of as-built drawings

1.12 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Provide adequate storage space for all electrical equipment, conduit, and materials delivered to the job site under a weather protected enclosure. Location of the space will be designated by the Owner's Field Representative. Equipment set in place in unprotected areas must be provided with temporary protection.

1. Be responsible for the care and protection of electrical equipment until it has been fully tested and accepted.
2. Protect materials with permanent factory finish from damage by covering.
3. Protect conduit openings with temporary plugs or caps.

1.13 WARRANTY

A. Warranty: Provide a one-year parts and labor warranty from date of substantial completion for all equipment and installation. Comply with requirements of Division 01.

1. A copy of the warranty on the Electrical Contractor's letterhead shall be provided as a requirement prior to final payment.

1.14 SCOPE OF WORK SPECIFIED IN DIVISION 26 AND DIVISION 28 SECTIONS

A. Furnish all labor, materials, equipment, technical supervision, and incidental services required to complete, test, and leave ready for operation the electrical systems as specified in the Division 26 Sections, Division 28 Sections that this section applies to per paragraph 1.1 Related Documents, and as indicated on Drawings.

B. Provide empty raceway systems consisting of conduits, wireways, surface raceways, nylon pull strings, outlet boxes, pull boxes, cover plates and cable trays as indicated for telephone, data, and audio/video wiring, for work specified in all Division 27 Sections, and for work specified in all Division 28 Sections.][Division 28 Sections that this section does not apply to per paragraph 1.1 Related Documents.

1.15 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Furnishing and mounting of all electric motors – Divisions 14, 21, 22 and 23.

B. Furnishing, mounting, and wiring of all electro-mechanical temperature, pressure, level, and flow control devices, high and low temperature limit switches, door limit switches, and solenoid valves – Divisions 22, 23 and 25.

C. Furnishing and wiring of low voltage thermostats – Division 23.

D. Furnishing and installing low voltage instrumentation and control wiring – Divisions 21, 22 and 23, except where otherwise indicated.

E. Furnishing and mounting of starters, disconnect switches, control wiring, and integral controls on package self-contained building service equipment – Divisions 14, 21, 22 and 23, except as otherwise indicated.

F. Furnishing and installing of food service equipment and control wiring including integral controls and power – Division 11.

G. Furnishing of receptacles, switches, device plates, supports, and enclosures on laboratory equipment – Division 12.

H. Furnishing and installing field prime and finish painting – Division 09, except as specified in Division 26 Sections and Division 28 Sections that this section applies to per paragraph 1.1 Related Documents.

I. Telephone equipment and wiring – Division 27.

J. Audio/Video equipment and wiring – Division 27.

K. Data LAN equipment and wiring – Division 27.

PART 2 - PRODUCTS

2.1 ACCESS DOORS

A. Furnish access doors in conformance with Division 08 as required to make accessible all controls, motors, electrical boxes, and other equipment installed by the Electrical Trades or as required by Code.

2.2 SEALING OF OPENINGS

A. Seal openings around electrical materials (conduit, raceways, cable trays, panels, etc.) with fire and smoke stop systems where floors, fire rated walls, and smoke barriers are penetrated. Fiberglass is not acceptable. Fire and smoke stop systems shall be UL listed and shall have a fire rating equal to or greater than the penetrated barrier. Fire and smoke stop systems shall be in conformance with Division 07.

2.3 SLEEVES

A. Provide conduit sleeves where conduits pass through concrete floors, walls, beams, and ceilings.

B. Sleeves shall be galvanized rigid steel conduit. Do not use aluminum conduit. Where specific sizes are not indicated on the Drawings, sleeves shall be sized to provide one-half (1/2) inch clearance around the outside surface of the item for which they were installed. They shall be cut flush with wall surfaces and shall extend one inch, or as directed, through floor. Sleeves shall be packed with approved non-combustible packing material and sealed with sealant to prevent passage of air, liquid, or fumes from one area to another. The filler and sealant materials used shall be rated at least equal in fire resistance to the construction material being penetrated. Floor sleeves shall be sealed between floor and sleeve with concrete grout.

2.4 EXPANSION FITTINGS

A. Provide expansion fittings in all conduits and cable trays that cross building expansion joints, both in concrete slabs and where exposed, and provide bonding jumpers where required to maintain electrical continuity.

2.5 FRAMED ONE-LINE DIAGRAM

A. Provide a framed copy of the one-line diagram depicting the incoming source, the main electrical equipment, and the loads being served from the main electrical equipment as shown on the Electrical Drawings including all “as-built” conditions. The framed one-line diagram shall be mounted on the wall in the main electrical room. Frame shall include glass assembly to protect the drawing and shall accommodate a 30 inch by 42 inch drawing size. Entire drawing including title block information shall be clearly displayed. Drawings shall be updated to include any factory or field modifications and shall be a blackline drawing on a white background. Coordinate drawing requirements with the Architect/Engineer prior to installation.

PART 3 - EXECUTION

3.1 ELECTRICAL DEMOLITION WORK

A. General: Perform electrical demolition work in a systematic manner. Use such methods as outlined below to complete work indicated on the Drawings.

B. Obtain approval from the Owner prior to interrupting existing services. All service interruptions shall be at a time suitable to the Owner. Where the Owner approves service interruptions at times resulting in premium time work to this Contractor, this Contractor shall include the premium time in his Base Bid.

C. The associated raceway system (conduit, boxes, supports, etc.) and wire of equipment indicated to be demolished shall be removed from the equipment back to the source as noted below:

1. Power: Remove raceway system and wire back to the panel or power source.

   a. When the circuit originates from the panel and serves no other loads, remove raceway system and wire back to the panel, and relabel the associated circuit breaker or fused switch as “spare”.
   b. When the circuit originates from a panel but continues on to other loads not intended to be demolished, remove raceway system and wire back to first junction box.
   c. When the removal of the circuit to the equipment to be demolished affects “downstream” devices not indicated to be demolished, re-feed “downstream” devices.

2. Fire alarm wiring: Remove as indicated on the Drawings. Fire alarm system shall remain operational during building occupied hours in all tenant occupied spaces.
3. Data system wiring, telephone wiring, or other auxiliary systems wiring: Remove raceway system and wiring back to communication room or other source.
4. Raceway systems in walls to remain: Abandon raceway systems in place and install blank cover plates.
5. Raceway systems above accessible ceilings or other accessible locations: Remove raceway systems.

D. Perform a circuit trace prior to deactivating feeders and branch circuits to ensure maintaining electrical power in adjacent unrenovated area.

E. Conduit being demolished that is installed in floor slabs shall be cut 1/2 inch below the floor, and the floor shall be patched.

F. Where applicable, existing in-place raceway systems (conduit, boxes, supports, etc.) may be reused for new work providing that the installation is in accordance with requirements for new work found in Division 26 Sections and Division 28 Sections that this section applies to per paragraph 1.1 Related Documents.

G. Where equipment or fixtures are removed, outlets shall be properly blanked-off and conduits shall be capped. After alterations are completed, the entire installation shall present a “finished” look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

H. Materials salvaged from this work shall not be reused except where reuse is specifically indicated.

I. Existing fixtures and electrical equipment removed, not reused, and not specifically indicated to be turned over to the Owner shall be legally and properly disposed of off Owner’s property.

J. Existing fixtures and electrical equipment specifically indicated to be turned over to the Owner shall be disconnected, removed, and turned over to the Owner in an undamaged condition to an onsite storage area as directed by the Owner.

3.2 TEMPORARY SERVICES

A. Provide temporary lighting, power, and telephone service as described in Division 01.

B. The existing building will be occupied during construction. Maintain electrical services and provide necessary temporary connections and their removal at no additional expense. The existing service shall not be removed until the new services have been installed and made operational in order to minimize shutdown time during transfer of services. The Electrical Contractor shall be responsible for installing and maintaining a temporary service to the existing electrical equipment. Route temporary service in a manner that does not interfere with the convenience of the Owner.

3.3 CUTTING AND PATCHING

A. Refer to Division 01 for requirements for cutting, patching, and refinishing work necessary for the installation of electrical work.

B. The cutting of holes through the existing building construction shall only be done by the use of abrasive saws and rotary coring machines. The use or hammer and drill points will not be permitted. The openings shall not be cut larger than necessary for the installation of the electrical work. Openings shall then be grouted in. Where existing piping, etc., is removed, the unused openings shall be grouted in.

C. The drilling or punching of structural members, such as holes through beams or columns, shall not be done without the specific permission of the Architect/Engineer.

D. Cutting of holes through floors and walls shall be done only at such locations as directed by the Architect/Engineer.

E. Cooperate with the other Trades so that all cutting and repairing in any given area will be done simultaneously.

F. Electrical work which may interfere with building systems uncovered by the cutting of new openings in the present building including but not limited to piping, ducts, or other mechanical equipment as well as conduits and outlets shall be removed at the direction of the Architect/Engineer.

3.4 EQUIPMENT FOUNDATIONS AND SUPPORTS

A. Furnish foundations and supports for electrical equipment and materials as required by codes, as listed hereinafter, and shown or noted on the Drawings.

B. Provide necessary inserts, rods, structural steel frames, brackets, platforms, etc., for equipment suspended from ceilings or walls, such as conduits, panels, etc.

C. Inserts for equipment support shall be lead shield anchors for small work and expansion shields for large work. Wooden plugs will not be allowed. Do not use metal roof decking and cellular floors for supporting equipment.

D. Provide and install concrete bases 4" above finished floor with leveling channels, where noted, for floor-mounted equipment such as unit substations, transformers, switchboards, distribution panels, motor control centers, etc.

E. Enclosures for panelboards, motor starters and disconnect switches shall be mounted on 1/2” spacers when mounted in a room below grade on exterior walls or 1/4” spacers when mounted in a room at or above grade on an exterior wall.

3.5 COORDINATION WITH OTHER TRADES

A. Install work in order to avoid interferences with the work of other Trades. The Electrical Contractor shall be responsible for removing and relocating any work which, in the opinion of the Owner’s Representative, causes interferences.

B. Should construction conditions prevent the installation of switches, conduit, outlet boxes, junction boxes, conductors, lighting fixtures, and/or other related equipment at locations shown on the Drawings, minor deviations may be permitted, shall be as directed by the Architect/Engineer and shall be made without additional cost to Owner.

C. The Electrical Trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.

1. All patching and repairing of any such damaged work shall be performed by the Trades which installed the work, but the cost shall be paid by the Electrical Trades.

3.6 ASSEMBLY AND CONNECTION OF EQUIPMENT

A. Assembly of Equipment:

1. The Contract Drawings and Specifications indicate items to be purchased and installed which are noted by a manufacturer's name, catalog number and/or brief description.
2. The catalog number may not designate all the accessory parts and appurtenances required for the particular use or function.
3. Arrange with the manufacturer for the purchase of all items required for the complete installation and efficient operation.

B. Equipment Connections:

1. Connections to equipment, motors, lighting fixtures, etc., shall be made in accordance with the shop drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished.
2. Any and all additional connections not shown on the Drawings but called for by the equipment manufacturer's shop drawings or required for the successful operation of the particular equipment furnished shall be installed as part of this Contract at no additional charge to the Owner.

3.7 FIELD QUALITY CONTROL

A. Testing Conduits: Conduits which are installed underground or concealed in concrete floor slab, foundations, etc., shall be cleared of foreign material and obstructions after installation and before conductor or pull wires are draw-in by wire brushing, swabbing, and employing an iron or hardwood mandrel which is 1/4" smaller in diameter than the internal diameter of the duct or conduit. Pulling wires shall be left in empty conduits.

B. Tests and Inspection:

1. When the systems are completed, operate equipment as directed by Architect/Engineer. Replace all faulty equipment. Make necessary adjustments before final acceptance.
2. Perform all tests required by State, City, County and/or other agencies having jurisdiction.
3. Provide all materials, equipment, etc., and labor required for tests.
4. Perform cable and equipment testing as specified.

C. Cleaning:

1. Keep premises free from accumulation of waste materials and rubbish. At the completion of the work, remove all rubbish from and about the building, and leave the electrical systems clean and ready for use.
2. Final clean-up shall include washing of fixture lenses, switchboards, substations, transformers, motor control centers, distribution panels, lighting panels, etc., to remove shipping and/or construction dust and debris. Fixture reflectors and/or lenses with water marks or cleaning streaks will not be accepted.

D. Painting:

1. In general, no painting is required by Electrical Trades other than touch-up of factory-finished electrical equipment.

END OF SECTION 26 0500

SECTION 26 0519 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (0-600V)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conductors and cabling for buildings and structures electrical systems under 600 volts.
2. Wire and cable systems as required, and all material and equipment, including wire, cable, connectors, lugs, fittings, and identification, as indicated or specified.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

1. Conductors - Each type and size of wire and cable. Identify material, construction data, insulation thickness, and jacket thickness.

1.4 QUALITY ASSURANCE

A. Wire, Cable and Components: Listed by Underwriters' Laboratories as meeting National Electrical Code and NFPA 70 requirements and be so labeled.

B. Furnish wire and cable on which standard factory tests established by AEIC, ANSI, ASTM, ICEA and NEMA have been performed.

C. Furnish cable tests as specified in 260570.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver all wire and cable to the site on reels or in coils, plainly marked for complete identification, including the wire or cable size, the number of conductors, type of wire or cable, length, weight, thickness and character of the insulation and the name of the manufacturer.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. General Requirements: Furnish wire and cable per standard specifications established for such material and construction by ASTM, ANSI, IPCEA and NEMA, where applicable. All conductors shall be copper unless otherwise specified. Feeders 100 amperes and above shall be aluminum. Minimum size of conductors shall be No. 12 AWG, except 120 volt control conductors which may be No. 14 AWG and 90 volt and less shall be as specified. Furnish conductor sizes as indicated. Conductors shall be stranded for sizes No. 14 AWG and larger. Conductors smaller than #14 AWG shall be as specified in the sections requiring use of such conductors.

1. Manufacturer: Provide products of one of the following:

a. Cerro Wire
b. Encore

c. General Cable Corporation
d. Prysmian
e. Republic Wire
f. Southwire
g. United Copper Industries

B. Wire for General Interior and Exterior Use: Single conductor, annealed copper, NEC Type XHHW, THHN and THHW rated 90°degC or THHN/THWN rated 90 degC in dry locations and 75 degC in wet locations, or NEC Type THW, THWN and XHHW rated 75 degC, all with 600 volt insulation.

C. Wire for Underground Service Entrance: Single conductor, annealed copper, NEC Type USE rated 75 degC, 600 volts.

D. Wire for Direct Burial or In Underground Duct or Conduit: Single or multi-conductor, as indicated on the Drawings, NEC Type USE rated 75 degC, 600 volts.

E. Wire for Use in High Temperature Areas as Indicated: Single conductor annealed copper, NEC Type FEP or PFA rated 200 degC, 600 volts.

F. Cable types MC, MI, NM, NMC or NMS shall not be used unless specifically noted on the drawings or in the specifications.

2.2 CONNECTORS FOR SPLICING COPPER CONDUCTORS

A. Connectors for Straight Splicing (Butt Splice) Conductors Up to and Including No. 8 AWG: Uninsulated solderless compression type.

1. Manufacturer: Provide one of the following:

a. Burndy "Hylink”
b. Panduit
c. Thomas & Betts "Sta-Kon"

B. Connectors for Straight Splicing Conductors No. 6 AWG and Larger: Uninsulated solderless compression 2-way type.

1. Manufacturer: Provide one of the following:

a. Burndy “Hylink”
b. Thomas & Betts 54500 Series

C. Connectors for Pigtail Splicing Conductors Up to and Including No. 8 AWG: Solderless type with a metallic insert connector within a plastic insulating cover having a temperature rating of 105 degC, 600 volts.

1. Manufacturer: Provide one of the following:

a. Buchanan
b. Ideal
c. Scotchlok

D. Connectors for 3-Way Splicing Conductors No. 6 AWG and Larger: Uninsulated solderless compression type.

1. Manufacturer: Provide one of the following:

a. Burndy “Hylink”
b. Thomas & Betts 54700 Series

E. Connectors for termination of motor loads to branch circuits: Set screw type, clean insulation for termination inspection multitap.

1. Manufacturer: Provide one of the following:

a. Burndy Clear UNITAP
b. Thomas & Betts CSB

2.3 LUGS FOR TERMINATING COPPER CONDUCTORS

A. Lugs for Terminating Power Conductors Up To and Including No. 8 AWG: Solderless type, manufacturer's standard, unless otherwise specified.

B. Lugs for Terminating Power Conductors No. 6 AWG and Larger: Solderless compression type, one hole for No. 6 AWG through No. 4/0 AWG inclusive, and two hole for larger sizes.

1. Manufacturer: Provide one of the following:

a. Burndy Type YA-L
b. Thomas & Betts Series 54000

C. Lugs for Terminating Control and Switchboard Wiring: Solderless compression type with tinned ring tongue.

1. Manufacturer: Provide one of the following:

a. Burndy "Hylug"
b. Thomas & Betts "Sta-Kon"

2.4 INTERLOCKED ARMOR CABLE FITTINGS

A. Splicing Sleeves: Metal enclosed, air-filled type for indoor use and compound-filled for outdoor use, equipped with terminators as specified below.

1. Manufacturer: Provide one of the following:

a. G & W Electric Specialty Company
b. PLM Products Division
c. Thomas & Betts

B. Terminators: Armor grounding type, non-watertight for indoor use and watertight for outdoor use.

1. Manufacturer: Provide one of the following:

a. G & W Electric Specialty Company
b. PLM Products Division
c. Thomas & Betts

2.5 INSULATING TAPE

A. General Use Tape:

1. Tape shall be vinyl all weather designed for continuous operation in -18°C to 105° applications and shall be 7 mils thick.
2. Manufacturer: Provide one of the following:

a. Okonite Type CLF Catalog Series 602-20
b. 3M Scotch Super 33

2.6 MISCELLANEOUS

A. Wire Labels for Identification of Conductors.

1. Manufacturer: Provide products of one of the following:

a. Brady
b. Westline

B. Lubricating Compound:

1. Manufacturer: Provide products of one of the following:

a. American Polywater Corporation
b. Ideal 77 Yellow
c. Wire Lube

PART 3 - EXECUTION

3.1 GENERAL

A. Install all wiring in raceway systems unless otherwise specified. Install wiring only in completed raceway systems and when systems are protected from the weather. Install conductors continuous, without splices, between equipment, where possible. Where splices are required, make up splices in boxes; do not use fittings for same.

B. Install phase and neutral conductors of each branch or feeder circuit in a single conduit except where paralleling circuits are indicated. Install paralleling circuits of identical makeup and length as the paralleled circuit, and terminate conductors at the same location, mechanically and electrically, at both ends, to ensure equal division of the total current between conductors.

C. All 120 volt branch circuits exceeding 100 feet in length shall be minimum size #10 AWG.

D. For interior branch circuits, provide a separate neutral conductor for each phase conductor for circuits supplying 120 volt convenience receptacles. Sharing neutrals between phase conductors shall not be permitted.

E. Continuously lubricate all non-armored cables of the larger sizes at the pull-in point of conduit systems with an approved compound compatible with conductor insulation or jacket.

F. Install conductors in such a manner that the bending radius of any wire or cable is not less than the minimum recommended by IPCEA and/or the manufacturer. Do not exceed manufacturer's recommended values for maximum pulling tension applied to any wire or cable.

G. Connect all power wiring to equipment such that phasing shall be A-B-C-N left to right, top to bottom and front to back, where possible, and permanently identify phasing on the structure or housing adjacent to bus. Phase identification A-B-C is equivalent to transformer phase identification X1-X2-X3 and H1-H2-H3.

H. Connect phase wiring to all 3 phase receptacles to insure the same phase rotation in all receptacles with interchangeable plugs.

3.2 COLOR CODING, CONDUCTOR AND CABLE IDENTIFICATION

A. Provide single conductor cables having black insulation for power feeders and subfeeders. Identify individual feeder and subfeeder conductors as to phase connection and voltage by means of wire labels and color coding at each pull box, junction box, manhole, handhole, vault, lighting fixture handhole, splice and termination.

B. Refer to Section 260553 “Identification for Electrical Systems” for conductor and cable identification requirements.

3.3 IN UNDERGROUND DUCT SYSTEMS

A. Brush and swab the duct line before pulling cable. When installing cables of large sizes, use flexible cable feeders of an appropriate size to lead the cable from the reel into the duct mouth. In manholes and handholes, install power cables exposed on cable racks and control and special system wiring in rigid steel conduit systems. In passing cables through manholes and handholes, avoid crossovers so that each cable is accessible when placed on racks, and where feasible, install each cable in the duct in the same relative position throughout the underground system, unless otherwise required or indicated. Install cables so that spare ducts are accessible for use in the future.

3.4 SPLICES AND TERMINATIONS

A. Splice and terminate conductors with connectors and lugs as specified for the specific size and type of conductor. Do not splice armored cable except where cable lengths are limited by reel capacity. Do not splice direct burial cable underground. Indent all compression type connectors and lugs with tools as recommended by the connector or lug manufacturer.

B. Thoroughly clean wire ends before connectors or lugs are applied. Before installing a compression connector or lug on an aluminum conductor, apply an aluminum joint compound to the exposed conductor and wire brush through the compound to remove the aluminum oxide film. Install the connector or lug immediately after wire brushing the conductor.

C. Whenever aluminum or copper lugs are terminated on aluminum bus, use a Belleville washer and two tin or cadmium plated washers, one on each side in combination with aluminum joint compound on all contacting surfaces. Tighten bolts until Belleville washer is flat.

D. Insulate all bare surfaces of conductors with a minimum of four layers (half lap in two directions) of electrical insulating tape. On larger splices and terminals, build up connection with electrical insulating putty before applying tape, to eliminate both sharp edges and voids.

E. Terminate all armored cables at equipment with an approved type of armored cable terminator and terminate cable ground conductors on equipment ground bus. Where splices are required in armored cables, use approved splicing sleeves. Locate splicing sleeve outside of and adjacent to the tray, not in the tray.

3.5 FIELD QUALITY CONTROL

A. Perform testing on all conductors as indicated in the Electrical Testing and Power Systems (26 0570) Section.

END OF SECTION 26 0519

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M,Grade A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1
2. NECA 101

B. Comply with requirements in Section 07 8413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 5000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 3000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 9100 "Painting" and Section 09 9600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. Raceway systems as required, and all equipment and material, including conduit, fittings, boxes, and wireways, as indicated or specified.

1.3 SUBMITTALS

A. Product Data: Submit complete data on each item. Coordinate the items, as they relate to the work, prior to submittal. Shop drawings shall include:

1. Conduit and fittings
2. Boxes
3. Wireways

B. Submit Owner's Operation and Maintenance Manuals for systems and equipment as follows:

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit, Elbows, and Couplings: Zinc-coated hot dip galvanized threaded steel per ANSI C80.1 "Specification for Rigid Steel Conduit, Zinc-Coated" and UL6. Each length of conduit shall be threaded on both ends.

1. Manufacturer: Provide products of one of the following:

a. Allied
b. Republic
c. Wheatland

B. Intermediate Metal Conduit (IMC), Elbows and Couplings: Zinc-coated hot dip galvanized per UL 1242. Each length of conduit shall be threaded on both ends.

1. Manufacturer: Provide products of one of the following:

a. Allied
b. Republic
c. Wheatland

C. Electrical Metallic Tubing (EMT): Zinc-coated steel per ANSI C80.3-1977 "Specification for Electrical Metallic Tubing, Zinc-Coated".

1. Manufacturer: Provide products of one of the following:

a. Allied
b. Republic
c. Wheatland

D. Flexible Steel Conduit: Per UL-1, "Flexible Steel Conduit".

1. Manufacturer: Provide products of one of the following:

a. Anaconda
b. Electriflex

E. Liquid-Tight Flexible Steel Conduit: Per UL-1, "Flexible Steel Conduit", with a PVC jacket.

1. Manufacturer: Provide products of one of the following:

a. Anaconda
b. Sealtite
c. Electriflex

2.2 ELECTRICAL PLASTIC CONDUIT

A. Heavy Wall Conduit: Schedule 40, 90 C, UL-rated, construct of polyvinyl chloride (PUC) and conforming to NEMA TC-2, for direct burial.

B. Thin Wall Conduit: Type A, UL-rated for concrete encasement underground, construct of polyvinyl chloride compound C-2000, and UL-listed in accordance with NEC Article 347.

C. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

D. Manufacturers: Provide products of one of the following:

1. Cantex
2. Prime Conduit, Inc.
3. National Pipe

2.3 CONDUIT FITTINGS

A. Fittings for Rigid Galvanized Steel or Intermediate Metal Conduit: Cast or malleable iron bodies, cadmium or zinc-plated, with taper threads, screw attached cover plates, and gaskets when located in areas requiring gaskets as specified in Part 3.

1. Manufacturer: Provide products of one of the following:

a. Appleton Form 35
b. Crouse-Hinds Form 8
c. Steel City/Thomas & Betts
d. Topaz

B. Expansion Fittings for Rigid Galvanized Steel or Intermediate Metal Conduit: Cast or malleable iron bodies, with threaded end caps for receiving fixed and movable conduits, metallic pressure packing and copper bonding jumper assembly, and providing for a minimum of 2 inches movement of the conduit in either direction.

1. Manufacturer: Provide products of one of the following:

a. Appleton
b. Crouse-Hinds

c. O-Z
d. Thomas & Betts

C. Couplings and Connectors for EMT: Zinc-plated steel, compression or set screw type.

1. Manufacturer: Provide products of one of the following:

a. Appleton
b. ETP
c. Midwest
d. Steel City/Thomas & Betts

D. Conduit Unions on Continuous Run:

1. Manufacturer: Provide products of the following:

a. Erickson

E. Expansion Fittings for EMT:

1. Manufacturer: Provide products of the following:

a. Thomas & Betts

F. Fittings for Flexible Steel Conduit: Malleable iron or steel, zinc or cadmium plated, securing the conduit by clamping action around the periphery of the conduit. Do not furnish fittings that anchor the conduit by means of set screws.

1. Manufacturer: Provide products of one of the following:

a. Appleton
b. ETP
c. Steel City/Thomas & Betts

G. Fittings for Liquid-Tight Flexible Steel Conduit: Designed to maintain the liquid-tight feature of the installation.

1. Manufacturer: Provide products of one of the following:

a. Appleton ST Series
b. ETP
c. Thomas & Betts 5331 to 5360

H. Locknuts for Rigid Steel or Intermediate Metal Conduit: Malleable iron or steel, zinc or cadmium plated.

I. Bushings for 1 Inch and Smaller Rigid Steel Conduits, Intermediate Metal Conduits: Insulating plastic type of non-burnable thermosetting phenolic, conforming to Underwriters' Laboratories requirements. Do not furnish non-rigid plastic bushings.

J. Bushings for 1-1/4 Inch and Larger Rigid Steel or Intermediate Metal Conduits: Malleable iron or steel, zinc or cadmium plated, with insulating insert of thermosetting plastic as specified for smaller conduit bushings, molded and locked into the bushing ring.

2.4 OUTLET BOXES

A. Sheet Steel Boxes: Galvanized or sherardized stock not less than No. 14 gage, with knockout openings, single or multiple gang, with extensions, adapters, plaster rings, tile covers, fixture studs and cover plates. Furnish accessories with same gage and finish as specified for boxes, except where special finishes are specified for covers and device plates in Section 26 2726. Provide sizes per NEC requirements for wiring space, except where minimum sizes are specified under Part 3.

1. Manufacturer: Provide products of one of the following:

   a. Appleton
   b. RACO
   c. Steel City

B. Cast or Malleable Iron Boxes: Galvanized or cadmium plated, single or multiple gang, with taper threaded hubs, adapters and cover plates. Furnish cast metal, galvanized or cadmium plated accessories, except where special device plates are specified in Section 26 2726. Furnish gaskets when located in areas requiring gaskets as specified in Part 3. Provide sizes per NEC requirements for wiring space, except where minimum sizes are specified under Part 3.

1. Manufacturer: Provide products of one of the following:

   a. Appleton
   b. Crouse-Hinds
   c. Pyle-National
   d. Russelstoll
   e. Steel City/Thomas & Betts

C. Aluminum or Aluminum Alloy Boxes: Single or multiple gang, with taper threaded hubs, adapters and cover plates. Furnish cast aluminum or aluminum alloy accessories, except where special device plates are specified in Section 26 2726. Furnish gaskets when located in areas requiring gaskets as specified in Part 3. Provide sizes per NEC requirements for wiring space, except where minimum sizes are specified under Part 3.

1. Manufacturer: Provide products of one of the following:

   a. Appleton
   b. Crouse-Hinds
   c. Pyle-National
   d. Russelstoll

2.5 PULL AND JUNCTION BOXES

A. Boxes Less than 5 Inches by 5 Inches: Conform to requirements specified for Outlet Boxes.

B. Sheet Metal Boxes: Code gage, full seam welded with bent-in flanges seam welded at corner joints, screw fastened cover of same gage as box. Fasten cover with brass machine screws. Galvanize box and cover after fabrication. Provide sizes conforming to NEC requirements for wiring space, except where boxes of larger size are indicated. Furnish gaskets when located in areas requiring gaskets as specified in Part 3.

C. Cast or Malleable Iron Boxes: Code gage, with threaded hubs or conduit bosses for field drilling and tapping, screw fastened cover of same gage as box. Fasten cover with brass machine screws. Galvanize box and cover after fabrication. Provide sizes conforming to NEC requirements for wiring space, except where boxes of larger size are indicated. Furnish gaskets when located in areas requiring gaskets as specified in Part 3.

1. Manufacturer: Provide products of one of the following:

a. Hoffman
b. O-Z

D. Aluminum or Aluminum Alloy Boxes: Code gage, with threaded hubs or conduit bosses for field drilling and tapping, screw fastened cover of same gage as box. Fasten cover with stainless steel machine screws. Provide sizes per NEC requirements for wiring space, except where boxes of larger size are indicated. Furnish gaskets when located in areas requiring gaskets as specified in Part 3.

1. Manufacturer: Provide products of one of the following:

a. Hoffman
b. O-Z

2.6 MISCELLANEOUS

A. Trapeze Hangers

1. Manufacturer: Provide products of one of the following:

a. Kindorf
b. Powerstrut
c. Unistrut

B. Shielding Paint

1. Manufacturer: Provide products of one of the following:

a. Thomas & Betts "KopR-Shield"

C. Sealant: Single component, non-sage urethane:

1. Manufacturer: Provide products of one of the following:

a. Sika Corporation “Sikaflex 1a”
b. Pecora Corporation "Dynatrol 1"
c. Sonneborn "Sonolastic NP-1"
d. Tremco “Dymonic”

PART 3 - EXECUTION

3.1 CONDUIT SYSTEMS

A. Install conduit for all main feeders which includes feeders to switchboards, distribution panels and panelboards.

B. Install RGS conduit for conduits passing through foundation walls with a 3 inch minimum concrete wall around the conduits and five (5) feet both sides of the wall.

C. Install RGS conduit for conduit elbows used to transition from below the slab and for all RGS conduit imbedded in the slab to vertical users passing through the floor slab.

D. Install RGS elbows and conduits for all vertical users at utility poles.

E. Install RGS conduits for all exposed exterior locations and wet locations.

F. EMT compression type connectors and couplings shall be used for all EMT conduits routed in damp locations or when the use of EMT in lieu of RGS is approved by the Engineer for exposed exterior locations. The use of set screw connectors and couplings is permitted for all other EMT raceways where equipment ground wires exist.

G. Install EMT concealed in wall cavities in offices and similarly “finished areas,” above suspended ceilings and in “unfinished areas” 10’-0” above finished floor.

H. Install flexible conduit in lieu of RGS or EMT for service to individual recessed fixtures, 1/2 inch minimum size. Use liquid-tight type of flexible conduit in lieu of non-jacketed flexible conduit in damp or wet locations.

I. Install liquid-tight flexible steel conduit for final connection to distribution transformers for final connections to all motors and other equipment subject to vibration or movement. Flexible conduits shall not exceed 6’-0” in length.

J. Install conduit systems as indicated, as required by the NEC, and as specified. Install conduit sizes as indicated. Where conduit sizes are not indicated, install sizes per NEC requirements, except do not use conduit sizes smaller than 3/4 inch. The use of 1/2” conduit is permitted from receptacle outlet boxes and switch outlet boxes to the nearest junction mounted in the ceiling space. 3/4” conduit minimum shall be used from the panelboards to the junction boxes and between junction boxes. Use 1/2 inch fixture stems optionally, unless otherwise indicated.

K. Install conduit concealed in office and similar finished areas, and exposed in all other areas unless otherwise indicated or specified.

L. Install all exposed and concealed conduit runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Keep conduit at least six inches away from parallel runs of high temperature surfaces, such as steam or hot water pipes and do not run conduit directly under cold water lines.

M. Conduits routed below floor slabs shall have a minimum of 3 inches of sand cover and shall not be required to be run parallel to building walls.

N. Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Take care to prevent the entrance of water and the lodging of concrete, plaster, dirt or trash in conduit, boxes, fittings and equipment during the course of construction. Free conduit of obstructions or replace the conduits. Where conduit joints occur in concrete slabs, or in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible. Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, etc. with standard galvanized plumbers pipe caps. Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.

O. Install conduit sleeves for all exposed conduits and cables passing through walls, ceilings or floors, and fill the void between sleeve and conduit with sealant flush with the end of the sleeve to seal the opening.

1. For conduit sleeves passing through fire rated walls, floors or ceilings, comply with requirements of Section 078413 “Through-Penetration Firestop Systems”.

P. Terminate conduit stubbed up through concrete floors for connections to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except that where required, use flexible conduit from a point 6 inches above the floor.

Q. Make changes in direction of runs with symmetrical bends, fittings or pull boxes. Do not use bends around outside corners; use fittings for same. Install elbows, bends and offsets having a minimum radius of curvature of 24 inches for 2 inch and 2-1/2 inch conduit, and 36 inches for 3 inch and larger conduit. Except where conduit runs are shown in exact detail, install pull points at not greater than 200 foot intervals in straight runs. Where bends are included between pull points, reduce this maximum permissible 200 foot separation between pull points by 50 feet for each 90 degree bend and 25 feet for each 45 degree bend. Figure deductions for all other angle bends on a similar basis. When bends are made in the field, make bends with an approved hickey or conduit bending machine. Make bends in 1-1/4 inch and larger conduits with standard conduit ells where possible.

R. Provide conduit nipples with two independent sets of threads. Do not use running threads on any part of the conduit system. Where conditions require joining two fixed conduits into a continuous run, use a conduit union, in place of running threads and coupling.

S. Install expansion fittings in exposed conduit runs of excessive length, where conduits cross building expansion joints, and where indicated.

T. Install double locknuts and bushings on all rigid conduit terminations into threadless openings. Increase length of conduit threads at terminations sufficiently to permit the bushing to be fully seated against the end of the conduit.

U. Use one hole malleable iron galvanized pipe straps for support of single conduits, or clevis type hangers. Support groups of conduit on trapeze hangers. Use threaded rod or pipe for hanger support. Do not use perforated strap or wire for conduit or hanger support. Use beam clamps or malleable iron or wrought steel with hook rods to grip the beam flange for conduit or hanger support; do not use C-clamp type fittings. Support exposed conduit at least every 8 feet if smaller than 2 inch, and every 10 feet if 2 inch and larger unless otherwise noted.

3.2 OUTLET, SWITCH, JUNCTION AND PULL BOXES

A. Outlet Boxes for Use with Rigid Steel Conduit in Non-Hazardous Areas: Sheet steel for flush or concealed work in dry locations; cast or malleable iron in exposed, damp or wet locations. Do not use sheet steel outlet boxes in utility areas.

B. Outlet Boxes for Use with Electrical Metallic Tubing: Sheet steel for flush or concealed work; cast or malleable iron for exposed locations.

C. Gaskets: Provide cover gaskets for boxes in damp or wet locations.

D. Pull and Junction Boxes for Use with Each Type of Conduit: As specified for outlet boxes for each conduit type under above paragraphs.

E. Install outlets for wall switches controlling lighting on the latch side of door where possible.

F. Support boxes independent of conduit and secure rigidly in place. Install boxes used for fixture support such that they are capable of carrying 100 pounds.

END OF SECTION 26 0533

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment identification nameplates
2. Raceway identification
3. Armored and metal-clad cable identification
4. Power and control cable identification
5. Floor marking tape
6. Underground-line warning tape
7. Warning labels and signs
8. Instruction signs
9. Cable ties
10. Miscellaneous identification products

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Plastic Laminate or Laminated Acrylic: Punched or drilled for screw mounting. Black engraved letters on a white face. Minimum letter height shall be 1/4 inch.

2.2 RACEWAY IDENTIFICATION

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits as specified voltages:

1. Black letters on a yellow field for 250V or less.
2. Black letters on a red field for over 250V and less than 600V.
3. Black letters on an orange field for circuits over 600V.
4. Legend for Systems below 600V: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4 inch black stripes on 10 inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.3 ARMORED AND METAL-CLAD CABLE IDENTIFICATION

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on a yellow field for 250v or less.
2. Black letters on a red field for over 250v and less than 600v.
3. Black letters on an orange field for circuits over 600v.
4. Legend for Systems below 600v: Indicate voltage.
5. Legend for systems over 600v: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3 inch high letters on 20 inch centers.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.4 POWER AND CONTROL CABLE IDENTIFICATION

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Power Conduits and Cables Red-Colored Tapes with these legends: ELECTRIC LINE FOR SYSTEMS LESS THAN 600V, HIGH VOLTAGE FOR SYSTEMS ABOVE 600V.
3. Communications Conduits and Cables Orange-Colored Tapes with the appropriate legends: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Multilayer laminate consisting of high-density polyethylene scrim coated with pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility compounded for direct-burial service.
2. Thickness: 12 mils.
3. Weight: 36.1 lb/1000 sq. ft.
4. 3 Inch Tensile According to ASTM D 882: 400 lbf, and 11,500 psi.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4 inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 foot maximum intervals in straight runs, and at 25 foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Equipment Identification Nameplates: On each unit of equipment, install unique designation label that is consistent with one line diagram tag nameplates, wiring diagrams, schedules, and the Operation and Maintenance Manual

1. Labeling Instructions:

a. Indoor and Outdoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/4 inch high letters on 1-1/2 inch high label.

b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
c. Fasten nameplates with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Switchboards
b. Feeder breakers
c. Panelboards: Both panelboard identification label and typewritten directory of circuits.
d. Enclosures and electrical cabinets
e. Access doors and panels for concealed electrical items
f. Emergency system boxes and enclosures
g. Motor starters
h. Enclosed switches
i. Enclosed circuit breakers
j. Enclosed controllers
k. Variable-speed controllers
l. Contactors
m. Remote-controlled switches, dimmer modules, and control devices

3.3 RACEWAYS AND CONDUCTOR IDENTIFICATION SCHEDULE

A. Concealed Raceways and Duct Banks, More Than 600 V:

1. Tape and stencil 4 inch wide black stripes on 10 inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3 inch high black letters on 20 inch centers. Stop stripes at legends. Apply to the following finished surfaces:

a. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
b. Wall surfaces directly external to raceways concealed within wall.
c. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V:

1. Snap-around labels. Install labels at 30 foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits 100 amperes or more and 120 volts or more to ground:

1. Self-adhesive vinyl tape applied in bands. Install labels at 30 foot maximum intervals.

D. Accessible Raceways, Cables, Junction Box Cover Plates and Pull Box Covers:

1. Self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

a. Power

E. Conductor Identification, 600 V or Less:

1. Identify individual phase conductors, neutral conductor and ground conductor of branch power and lighting circuits as to phase and system voltage by means of color coding in conformance with Sections 200-6 and 210-5 of the NEC.
2. Use the following identification scheme unless there are existing schemes being utilized by the Owner:

Phase			Neutral		Equipment Grounding Conductor	System
A	B	C	Normal Power	Emergency Power		
X	Y	Z	N	N	GRD.	Any Voltage
Black	Red	Blue	White	White/Red tracer	Green	120/208 Volt
Brown	Orange	Yellow	Gray	Gray/Red tracer	Green/Yellow Tracer	277/480 Volt

3. Where color schemes deviate from above, submit color schemes for approval of the Architect-Engineer prior to implementation. Provide conductor color coding by means of colored insulating materials or by means of colored wire labels attached to individual conductors in all outlet, pull or junction boxes and at all terminations.
4. Install color coding scheme labels at each switchboard, panelboard, distribution panel, power panel and motor control center.
5. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

F. Identify cable groups and conduit at entering and leaving locations in manholes, handholes and at terminations.

G. Tags shall be 1/8 inch thick lead die-stamped tags with punched ears. Fasten tags around the cable group or conduit with No. 12 AWG copper wire.

H. Identify cables entering or exiting conduits, passing through pull boxes, at each pullbox and at each termination location.

I. Conductor Identification, More than 600 V:

1. Identify cables and conductors in primary switches, vacuum breakers, 15 kV incoming line sections, building entry points, vaults, pull and junction boxes, manholes, and handholes.
2. Identify cables in cable tray at intervals of 40 feet, at each side of walls, and at terminations and splices by means of strip aluminum with raised letters.
3. Designate source and load, or feeder or cable identification on tags. Submit identification for the approval of the Architect-Engineer.
4. Tags shall be 1/8 inch thick lead die-stamped tags with punched ears. Fasten tags around the cable with No. 12 AWG copper wire.
5. Tags shall be made of polypropylene, injection molded characters integral with locking grids. Color additives and UV stabilizers shall be molded throughout the tags. Both the background and the characters have a minimum thickness of 0.040 inch.
6. Tags shall be horizontal orientation with a polyethylene tag holder. Tag holder shall have a 0.060 inch thickness punches with six slots for mounting.
7. Tags shall be 1 inch high character Everlast by Tech Products, Inc. (800-221-1311).
8. Information on tags shall be as noted and shown on drawing. Tags shall be approved by Engineering Services Department prior to installation.

J. Auxiliary Systems Conductor Identification:

1. Identify field-installed alarm, control, and signal connections.
2. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
3. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
4. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

K. Underground Lines:

1. Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for both direct-buried cables and cables in raceway.

L. Workspace Indication:

1. Install floor marking tape to show working clearances in the direction of access to live parts.
2. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Controls with external control power connections.

N. Operating Instruction Signs:

1. Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

O. Install instructional sign using adhesive-film-type labels.

END OF SECTION 26 0553

SECTION 26 0923 – LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. The objective of this section is to ensure the proper installation of the following lighting control devices not associated to networked lighting controls:

    a. Wall switch occupancy sensors
    b. Wall switch occupancy sensors with 0-10V dimming
    c. Photoelectric controllers

2. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensors, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system with automatic emergency power transfer, as described herein.
3. The occupancy sensor based lighting control devices shall accommodate all conditions of space utilization and all irregular work hours and habits.
4. The location and quantities of sensors shown on the Drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective room.

1.3 SUBMITTALS

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

B. Shop Drawings: Provide installation details for occupancy and light-level sensors.

1. Lighting plans indicating location, orientation, and coverage area of each sensor. The locations and quantities of sensors indicated on the Drawings are diagrammatic and indicate only the rooms which are to be provided with sensors and emergency lighting.
2. Interconnection diagrams showing field-installed wiring.

C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

D. Functional Testing Report: For all spaces equipped with lighting controls.

1.4 WARRANTY

A. Contractor shall warrant all equipment furnished in accordance with this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The suppliers obligation shall include repair or replacement, and testing without charge to the owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the owner's acceptance of the project. Warranty shall be for a minimum period of one (1) year.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.

C. All components shall be U.L. listed and meet all state and local applicable code requirements.

D. Wall switch products shall be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

E. It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with the occupancy sensor system.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems.

PART 2 - PRODUCTS

2.1 WALL SWITCH SINGLE POLE AND DUAL POLE OCCUPANCY SENSOR

A. Switching mechanism shall be latching air gap relay, compatible with LED Power supplies, electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices shall not be allowed. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the sensor's longevity.

B. Sensor shall utilize PIR based technology and be capable of detecting presence in the control area by detecting changes in the infrared energy. Small movements shall be detected such as when a person is writing while seated at a desk.

C. Sensor shall utilize signal technology to provide immunity to RFI and EMI.

D. Sensor shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. Fresnel lens shall be a Poly IR 4 based material to offer superior filtering capability of competing light sources, such as the sun and other visible light sources. Lens shall have grooves facing in to avoid dust and residue build-up which could affect IR reception. To assure detection at the desktop level uniformly across the space, sensor shall have a 2 level, 28 segment, multi-element Fresnel lens system. For protection against lens damage, sensor shall utilize a full radius lens brace.

E. Sensor shall have a coverage area of 900 sq. ft. for walking motion, with a field of view of 180 degrees.

F. Sensor shall operate at 277 VAC and shall be capable of switching 0 to 800 watt ballast or tungsten or 1/6 hp @ 120 volts, 60 Hz; 0 to 1200 watts for ballast or 1/3 hp @ 277 volts, 60 Hz.

G. Sensor shall have a built-in light level feature adjustable from 2 to 200 footcandles that holds lighting OFF when a desired footcandle level is present. Sensor shall have a time delay adjustable from 30 seconds to 30 minutes. Sensor shall have user-adjustable sensitivity setting. Adjustments and mounting hardware shall be concealed under a removable cover to prevent tampering of adjustments and hardware.

H. Sensor shall be set to 15 minute in vacancy mode.

I. The sensor shall utilize terminal style wiring. Sensor shall provide automatic equipment grounding to a metal junction box, and provide grounding to a metal cover plate.

J. Sensor shall have 100% off switch with no leakage current to load in OFF mode. In the event there is an open circuit in the AC line such as a ballast or lamp failure, the sensor shall automatically switch to OFF mode.

K. Senor color shall be white with white faceplate, unless noted otherwise on drawings.

L. Manufacturer: Provide the following:

1. Sensor Switch “WSX” Series
2. Lutron “Maestro” Series
3. Leviton “ODS” Series

2.2 PHOTOELECTRIC CONTROLLERS

A. Weatherproof for outdoor mounting, operating on 105-130 volt, 60 hertz power and having a single pole, single throw contact rated a minimum of 1800 watts incandescent lighting. Provide unit having preset adjustable turn-on and turn-off points from 1.0 to 12 footcandles and equipped with a time delay feature to prevent switching of lights due to transient lighting changes. Equip controller with a 1/2 inch pipe thread connection.

1. Manufacturer: Provide one of the following:

a. Acuity nLight
b. Intermatic Model K4100
c. Paragon CW201-00UL
d. Tork Model 2100

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: No. 12 AWG (minimum), complying with Division 26 Sections.

B. Power Wiring to Supply Side of Emergency Power Transfer Devices No. 12 AWG (minimum), complying with Division 26 Sections.

C. Control wiring between sensors and control units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated and TEFLON jacketed cable suitable for use in plenums.

D. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Wiring Method: Comply with Division 16 Sections. All wiring shall be installed in conduit. Minimum conduit size shall be ¾ inch.

B. Wiring Within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.2 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Sections.

END OF SECTION 26 0923

SECTION 26 0943 – NETWORKED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Work of this Section.

1.2 DESCRIPTION OF SYSTEM

A. These Specifications, together with the related Drawings and General Conditions of the Contract, comprise the requirements for the lighting control system.

B. Summary:

1. The lighting control system shall provide time-based, sensor-based and manual lighting control.
2. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed).
3. All system devices shall be networked together enabling digital communication and shall be individually addressable.
4. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity if network connectivity to the network system is lost.
5. The system architecture shall facilitate remote operation via a computer connection.
6. The system shall not require any centrally hardwired switching equipment for normal operation.
7. The system shall facilitate control through the building management system.

C. The lighting control system shall include de-centralized lighting control equipment including, control stations, control processing units and other user interface devices, wiring, and ancillary programming equipment. Type of lighting control equipment and wiring specified in this section includes the following:

1. Central processing unit and system interface; master interface providing coordinated control for all of the system's networked devices. The unit acts as the primary gateway for all BAS related connections.
2. Bridge/Digital Controller.
3. Power/Relay Packs.
4. Digital Touchscreens: Color digital touchscreen allowing the user access to local or system-wide actions such as preset programming, precise fixture controls, etc.
5. Digital Low Voltage Pushbuttons and Preset Stations.
6. Occupancy Sensors.
7. Photoelectric Sensors.

D. Abbreviations/Definitions:

1. Bridge/Digital Controller: A digital device which connects lighting control zones to a network backbone.
2. Digital Low Voltage Push Button/Preset: User interface pushbuttons (typically wall mounted) with a discrete address which transmit a low voltage digital signal via the communication bus to the bridge to initiate a selected on/off or dimming action for a preselected group of fixtures.
3. Occupancy Sensors: Devices with a discrete address which detect room occupancy status via infrared, ultrasonic, or microphone, or a combination of infrared and either ultrasonic or microphone technologies and transmit digital signals via the communication bus to the system to initiate a selected action for a preselected group of fixtures.
4. Power/Relay Pack: Device which accepts communication inputs, assigns an address to that device which establishes a zone and has 120/277 volt load rated contacts. When specified, this device also provides 0-10 VDC and line voltage dimming and UL 924 compliant emergency bypass control.

E. Related Sections include the following:

1. Division 25 Section "HVAC Instrumentation and Controls" for input and output requirements related to lighting controls.
2. Division 26 Section "Wiring Devices" for line voltage light switches.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated including, but not limited to:

1. All controls equipment and device cut sheets, one (1) for each variation, with the following minimum data:

a. Physical Dimensions
b. Operational Sequences
c. Typical Wiring and Installation Diagrams
d. Applicable listings as required in these specification and drawings (UL, IP, etc).
e. Applicable selected options with complete catalog numbers.
f. Selected Finish
g. Evidence that equipment is compatible with specified interface protocols (BAS, Fire Alarm, A/V, etc.).

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.

1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
2. Front elevations of all control panels and control stations including the customized legends on each device.
3. Wiring and Block Diagrams/Risers; Show project specific power and communications interconnections between all system components, interfacing systems (BAS, Fire Alarm, A/V, etc.) and power distribution systems. Indicate all associated cable and wire types.
4. Plans: Provide device and equipment locations, layouts and system interconnections overlaid on project specific floor plans. Identify devices and equipment types, tied to wiring diagrams and risers.

C. Operation and Maintenance Data: For control modules, control stations, normal system operation, emergency system, operation, and maintenance manuals. In addition to items specified in Division 1 Sections include the following:

1. Software manuals.
2. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
3. Operation of adjustable zone controls.
4. Testing, operation and adjusting of panic and emergency power features.

D. Functional Testing Report: For all spaces equipped with lighting controls.

1.4 COORDINATION

A. Coordinate lighting controls with Sections specifying distribution components that are interfaced with this system such as mechanical controls, AV systems and fire alarm.

B. Coordinate lighting control system with Tridium building automation system (BAS), existing or as provided under Division 23. Provide all necessary hardware and wiring to interface with the BAS through IP-based communications.

C. Equipment: Provide certified documentation that all tests outlined in ASHRAE 90.1-2013, Section 9.4.3 have been performed. Documentation to include:

1. Table/Spreadsheets of all applicable spaces with associated sensor, time clock, override and daylight operations for both occupied and unoccupied conditions.

1.5 WARRANTY

A. Special Warranty: Repair or replace components of lighting controls that fail in materials or workmanship within warranty periods specified below.

1. Warranty Period: Cost to repair or replace any parts for five (5) years from the date of Substantial Completion.
2. During the warranty period, provide 24 hours/day 7 days per week telephone technical assistance.
3. During the warranty period, provide 24 hour on-site response time.
4. Failures include, but are not limited to, the following:

a. Software: Failure of input/output to execute switching or dimming commands.
b. Failure of relays to operate under manual or software commands.
c. Damage of electronic components due to transient voltage surges.
d. Failure to switch relays to "on" status and to switch dimmer modules to full light output in power failure mode.
e. Failure or damage to pushbutton stations due to human use/abuse.

5. Provide software upgrades for all lighting control systems during the warranty period.

1.6 SPARE PARTS

A. Furnish spare parts described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Bridges/Digital Controllers: Provide two (1) spares.
2. Power/Relay Packs: Provide two (2) spares for each type installed.
3. Pushbutton Stations: Provide two (2) spares for each type installed.
4. Occupancy Sensors: Provide ten (2) spares.

1.7 DELIVERY, STORAGE AND HANDLING

A. Package for delivery to best protect finish surfaces while using the least amount of single-use packaging as possible. If possible, package and ship product using reusable blankets and fabrics or reusable cardboard and crate systems.

B. Protect materials against weather and contact with damp or wet surfaces from time of delivery through time of installation. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes.

C. When storing prior to installation, raise off floor on pallets, stack flat with protective material between to eliminate chance of creating nicks, scratches, and other imperfections and damage to finish surfaces, wrap weather-tight, and provide for air circulation within and around stacks and under temporary coverings.

D. Do not allow materials to become damp. Maintain temperatures at 60°F or higher, and humidity between 20% and 60% prior to, during and after installation.

1.8 CODES AND STANDARDS

A. IEEE Standard 2000.1-1998

B. UL 916 Energy Management Equipment

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a UL/CUL testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

E. UL 924 Emergency Lighting.

F. Michigan Energy Code 2015, adopting ASHRAE 90.1-2013.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Acuity Brands, nLight wired network control system
2. Touche Lighting Controls, room manager base system
3. Wattstopper, DLM system
4. Hubbell, NX System

2.2 SYSTEM DESCRIPTION

A. The lighting control system shall provide seamless control and monitoring of all lighting sysems included in the scope of work regardless of whether they are relay switched or dimmer controlled and switched or controlled via communication-based 0-10 VDC equipment. All lighting control equipment and devices shall be interconnected by a communication network buss making possible the sharing of control functions and status system wide. The system shall have astronomic clock, scheduling software, trending software, energy management software, administrative software, diagnostic software, programmable inputs and programmable outputs. Where communication links are broken between bridges and room controllers, the room control shall remain operational in some default basic operation.

B. All control inputs shall operate with IP Technologies, shall be discretely addressable and shall be connected to a communication bus originating from the LAN which is connected to the gateways and through the gateways which interconnect the bridges to the local occupancy sensors, daylight sensors, local pushbuttons, power/relay packs and low voltage control packs servicing the lighting in the area. Control inputs consist of occupancy sensors, photo sensors and pushbuttons. Required power for operating these inputs shall originate from the power packs or gateways and shall be transmitted via the communication bus. Control inputs shall be transferable over the network to affect lighting control patterns and zones regardless of to which relay or dimmer the loads are connected. Overrides for after hour use or cleaning shall be accomplished via pushbutton switch.

C. The system software shall be web-based and allow the user to remotely configure and monitor all devices including all of the following:

1. Customize device names
2. Configure device settings
3. Configure device fault settings
4. View device properties
5. Modify device current settings
6. Observe real time device/group operational statuses
7. Update device firmware
8. Zoning network devices
9. Creating lighting profiles that outline device operation
10. Scheduling lighting profiles to operate at prescribed times and on prescribed days
11. Provide access for remote online technical support
12. Print reports for network inventory and profiles
13. Develop reports to calculate and analyze savings in kWH and dollars
14. Develop reports to indicate usage in hours per zone

15. Develop reports to indicate daylight savings
16. Develop reports to indicate status of relays (fixtures)
17. Provide BACnet interface to BAS
18. Provide a matrix (software and printed) indicating address and physical location of all sensors. Software shall transfer information to BAS.

2.3 NETWORKED SYSTEM PUSHBUTTON AND PRESET STATIONS

A. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

B. Devices shall be installed into a single gang switch box and fit a standard GFI opening.

C. Provide button configurations, dimming capabilities and presets as indicated on drawings.

D. Devices shall be white unless otherwise indicated on drawings.

2.4 NETWORKED SYSTEM OCCUPANCY SENSORS

A. Provide dual-technology occupancy sensors designed for use with specified lighting control system.

B. Sensors shall be available in multiple lens options which are customized for specific applications.

C. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

D. Every sensor parameter shall be available and configurable remotely from the software and locally.

E. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas.

F. Sensors shall be white.

2.5 NETWORKED SYSTEM POWER/RELAY PACKS

A. Power packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system. Power packs/relays may be remote or integral to digital controller.

B. All devices shall have two RJ-45 ports minimum.

C. Every power pack parameter shall be available and configurable remotely from the software and locally.

D. Power pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. UL Listing under Energy Management or Industrial Control Equipment meets this requirement.

E. When required by local code, power pack shall be installed inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.

F. Power packs shall provide up to 16 amps switching of all lighting load and as 0-10 VDC dimming of LED drivers.

G. Specific power/secondary packs shall be available that are UL924 listed for switching of Emergency Power circuits.

H. Specific Secondary Packs shall be available that control small equipment such as louver/damper motors.

I. Specific secondary packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.

2.6 LIGHTING CONTROL PROFILES

A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.

B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.

C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.

D. Every device parameter (e.g. sensor time delay and photocell set-point) shall be configurable via a lighting control profile.

E. All lighting control profiles shall be stored on the network equipment and on the software's host server.

F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.

G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.

H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

2.7 MANAGEMENT SOFTWARE

A. Every device parameter (e.g. sensor time delay and photocell set-point) shall be available and configurable remotely from the software.

B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.

D. A printable network inventory report shall be available via the software.

E. A printable report detailing all system profiles shall be available via the software.

F. Software shall require all users to login with a User Name and Password.

G. Software shall provide at least three permission levels for users.

H. All sensitive stored information and privileged communication by the software shall be encrypted.

I. All device firmware and system software updates must be available for automatic download and installation via the internet.

J. Software shall be capable of managing systems interconnected via a WAN (wide area network).

K. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. No additional hardware shall be required.

L. BACnet IP gateway software shall communicate information gathered by networked system to other building management systems.

M. BACnet IP gateway software shall translate and forward lighting relay and other select control commands from BMS system to networked control devices.

2.8 LIGHTING CONTROL SEQUENCE OF OPERATION

A. Refer to Drawings for Sequence of Operation for interior and exterior lighting control.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment at locations indicated, and secure to ceilings, walls, floors or structural members as required.

B. Provide special cable as indicated or specified by manufacturer.

C. Install all wiring in conduit systems as indicated and as specified in Section 260533.

D. Provide final wiring and connections per the manufacturer's wiring diagrams.

E. Provide a dedicated power feed to each piece of equipment requiring line voltage power for operation.

F. Provide control wiring from life safety lighting control devices to normal power lighting control devices serving lighting in the same area as the life safety lighting controls. This 120-volt control wiring shall initiate the life safety lighting control panel relays and dimmers to the "on" and full light output position.

G. Communication bridges shall be installed in electrical closets or above lay-in ceilings at doorways at strategic locations. Gang bridges where possible to minimize 120volt wiring and to centralize their location for maintenance. They shall not be installed in spaces with open ceiling construction.

H. Central processing unit shall be installed in electrical closets.

I. Provide 120 volt power to each processing unit controller provided.

J. I/O devices and power packs for emergency lighting circuits shall be UL 924 rated.

3.2 QUALITY CONTROL

A. Independent Testing Laboratory: The control panels shall be tested and listed under the UL 916 Energy Management Equipment standards.

B. System Checkout and Training: A factory authorized technician shall functionally test the system and verify performance after contractor installation. Provide training for operations personnel on the set-up, programming, operation and maintenance of the lighting control system.

C. Adjusting: After completion of system wiring, connect, test, adjust, and readjust as necessary, all equipment in terms of design function and performance.

D. Demonstration: After checking has been completed and system is operational, demonstrate to the Owner the complete and correct functioning of all system components and equipment. These demonstrations shall consist of operating the controls through their normal full ranges and sequences. Simulate abnormal conditions to demonstrate proper functioning of the devices. Readjust settings to their correct design values and, after sufficient time, observe ability of controls to establish the desired conditions, noting abnormal deviations. Make necessary repairs, replacements or adjustments on items which fail to perform satisfactorily and repeat tests to demonstrate compliance with the design intend.

1. When system is in specified operational condition, and when pertinent operational functions have been demonstrated, system shall be accepted.

E. Test all life safety lighting control panels by simulating a power failure to the lighting panelboards serving the normal lighting in the space. Verify and make any adjustments to assure that if power fails in those panelboards or if the transfer switch changes states the life safety lighting control panels shall energize relays and all dimmers energize to full light output.

3.3 START UP SERVICES

A. Provide “on-site” start-up services to assist contractor in making final connections, programming, preparing schedules, aiming photo sensors, installing photo sensors, installing occupancy sensors and installing all the electronics.

3.4 TRAINING

A. The Contractor shall provide a training session for the Owner’s Representative.

B. The training session shall be conducted by a manufacturer’s qualified representative. The training program shall consist of instruction on the operation, adjustment, and maintenance of the lighting control devices.

3.5 COMMISSIONING

A. The Contractor shall commission the entire lighting control system consisting of testing and documenting all results. The tests shall consist of visiting each space and validating that the quantity, type of fixtures, voltage and wattage are documented in the administrative/trending software package.

B. Program each zone to validate that lighting levels in the spaces are uniform and that the lighting levels remain uniform with daylight harvesting in operation.

C. Validate that each photo sensor, occupancy sensor and pushbutton operate as specified and required. Document each device with its IP address and the room and group of fixtures it controls.

D. Test each space for operation during scheduled “on” hours and then for scheduled "off" hours to assure controls operate as intended. Document spaces and times when the spaces were tested.

E. Simulate a power outage to validate all emergency lighting operates as required.

F. Notify engineers five (5) business days prior to commencing testing for his witness of the testing in related areas and related times.

G. Engage a third party testing agent to perform ASHRAE 90.1-2013 compliant functional testing as outlined in Section 9.4.3.

3.6 PRODUCT SUPPORT AND SERVICE

A. Provide a factory authorized technician to verify the installation, test the system, and train the Owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:

1. The control system has been fully installed in accordance with manufacturer's installation instructions.
2. Low voltage wiring for overrides and sensors is completed.
3. Accurate "as-built" load schedules have been prepared for each lighting control panel.
4. Proper notification of the impending start-up has been provided to the Owner's representative.

B. Factory telephone support shall be available at no cost to the Owner during the warranty period and extended warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll-free number for technical support.

END OF SECTION 26 0943

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Lighting control and receptacle services as required, and all materials and equipment, including switches, receptacles, device plates, photoelectric controllers, time switches, lighting contactors and low voltage control systems, as indicated or specified.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data: Submit product data on each item. Coordinate the items, as they relate to the work, prior to submittal. Include the following:

1. Wall switches and plates
2. All receptacles including device plates.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Switches for Controlling Lighting Directly on AC Systems in General: Toggle-operated, white, specification grade, composition base, heavy duty, flush, quiet type, with provision for back and side wiring, and rated 20 amperes, 120/277 volts AC.

1. Manufacturer: Provide one of the following:

a. Arrow-Hart
b. Bryant
c. General Electric
d. Hubbell
e. Pass & Seymour

B. Key-Operated Switches for Controlling Lighting Directly on AC Systems: Identical to toggle-operated switches specified above except for key operation. Furnish 4 keys to the Owner.

2.2 CONVENIENCE RECEPTACLES

A. 20 Ampere Duplex Tamper-Resistant Convenience Receptacles for 120 Volt, Single Phase Service: Two straight blade, 2 pole, 3 wire, NEMA configuration 5-20R receptacles rated 20 amperes, 125 volts, NEMA performance standard, specification grade, for back and side wiring, white color.

1. Manufacturer: Provide one of the following:

a. Arrow-Hart

b. Bryant
c. General Electric
d. Hubbell
e. Pass & Seymour

B. 20 Ampere Duplex Tamper-Resistant Ground Fault Circuit Interrupter (GFCI) Convenience Receptacles for 120 Volt, Single Phase Service: Two straight blade, 2 pole, 3 wire grounding, NEMA configuration 5-20R receptacles rated 20 amperes, 125 volts, NEMA performance standard, specification grade, with provisions for back and side wiring, brown color.

1. Units shall have a test and reset button on the face of the receptacles and visible indication of a tripped condition.
2. Units shall have line and load terminal screws such that connection to load terminals shall provide feed through ground fault protection for “downstream” receptacles and/or loads connected to these terminals.
3. All receptacles shall be Underwriters’ Laboratories, Listed under 498 Receptacle requirements and 943 Class A requirements.

a. Manufacturer: Provide one of the following:

1) Arrow-Hart
2) Bryant
3) Hubbell
4) Pass & Seymour

2.3 DEVICE PLATES

A. Device Plates in Finished Areas: Stainless steel 302 finish.

A. Device Plates in Factory, Utility and Similar Areas: Zinc or cadmium plated steel.

B. Device Plates in Wet or Damp Areas and Outdoors: Weatherproof type. Provide spring-hinged gasketed covers on outdoor receptacles suitable for wet locations as defined in NEC Article 406.8.

C. Screws: Provide screws having a finish matching the plate.

2.4 POWER CORD REELS

A. Description: Standard or heavy duty power cord reel as required for applicable ampacities, including mounting base, retracting reel mechanism, cord, ball stop, mounting hardware, and pendant outlet box or connectors as indicated on the drawings.

B. Components shall be products from single manufacturer designed for use as a complete matching assembly of hardware and receptacles.

1. Manufacturer: Provide the following:
   a. Woodhead
   b. Reelcraft

C. Provide reel with a minimum cord length of 35’-0”, with hard service cord. Cord shall be rated for the ampacity and conductor quantities required to support the wiring devices indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment at locations indicated.

B. Install plates on flush mounted outlets with all four edges in continuous contact with finished wall surfaces without the use of plaster mats or similar devices. Do not use plaster or similar fillings. Install plates vertically, unless otherwise noted, with an alignment tolerance of 1/16 inch.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in {control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and, motor-control centers}.
2. Spare-fuse cabinets.

B. Related Sections:

1. Applicable sections of Division 26.

1.3 SUBMITTALS

A. Product Data:

1. Provide for each type of fuse specified.
2. Provide construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinet.

1.4 SPARE FUSES

A. Furnish spare fuses that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Provide three (3) of each size and type installed on this project.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses, and NFPA 70.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size, with system short-circuit current levels and with coordination study.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide one of the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting; Class L, time delay; Class RK1, fast acting; Class RK1, time delay; Class J, fast acting; Class J, time delay; Class T, fast acting.
2. Feeders: Class L, fast acting; Class L, time delay; Class RK1, fast acting; Class RK1, time delay; Class RK5, fast acting; Class RK5, time delay; Class J, fast acting; Class J, time delay.
3. Motor Branch Circuits: Class RK1, time delay.
4. Other Branch Circuits: Class RK1, time delay; Class RK5, time delay; Class J, fast acting; Class J, time delay.
5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

B. Install fuses where required with the ampacity shown on the drawings or where not indicated as follows:

1. Feeder Circuits: Sized to provide overcurrent protection of the conductors and to provide short circuit protection of the downstream equipment and shall have an ampacity equal to or less than the conductor ampacity.
2. Lighting and Appliance Branch Circuits: Sized to provide overcurrent protection of the conductors and to provide short circuit protection of the downstream equipment and shall have an ampacity equal to or less than the conductor ampacity.
3. Motor Branch Circuits: Sized to provide motor back-up overcurrent protection, short circuit protection and ground fault protection. Fuses shall be rated 125% of motor and full load amperes. Where motor service factors are greater than 1.0 increase the full load current accordingly. Where standard fuse size is not available, use next larger standard size fuse.
4. Fuses shall be selected to provide selective coordination.

END OF SECTION 26 2813

SECTION 26 2816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section specifies enclosed switches (safety switches) and circuit breakers as indicated and specified. Provider equipment supports and identification as specified.

B. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.

C. Related Sections:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 01 Specification Sections.

B. Submit Shop Drawings and complete product data on each of the following:

1. Safety switches
2. Enclosed circuit breakers

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

A. General Description: Fusible or non-fusible as indicated, quick-make, quick-break, NEMA "HD" heavy duty visible blade type, horsepower rated in ratings up to 200 amperes at 600 volts and up to 400 amperes at 250 volts, in NEMA enclosures specified or as required for environment present. Furnish 3 pole, single throw switches unless otherwise indicated, with voltage and current ratings as indicated. Short circuit rating with fuses shall not be less than 50,000 A.I.C. Silver or cadmium plate all contact surfaces including fuse clips.

B. Interlocking: Equip switches with an external operating handle and interlock the operating handle with the cover door such that the cover door cannot be opened unless the switch is in the "off" position. Provide means for triple padlocking the operating handle in the "off" position such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch cannot be closed. Equip switches with auxiliary contacts when such are indicated.

C. Fuse Clips: Standard rejection type for dual element cartridge type fuses as specified unless otherwise required.

D. Safety switches shall be furnished and installed as indicated on the drawing, with sizes and fusing as noted.

E. Safety switches inside of building shall be NEMA 1.

F. Safety switches for motors on cooling tower fans and similar applications shall be furnished with watertight, stainless steel enclosures NEMA 4X.

G. Safety switches mounted exterior of the building shall be NEMA type 3R.

H. Safety switches for two speed motors shall be six pole, single throw.

I. Manufacturers: Provide one of the following:

1. Eaton Cutler-Hammer H-600
2. General Electric Type TH
3. Siemens
4. Square D Heavy Duty

2.2 ENCLOSED CIRCUIT BREAKERS

A. General Description: Molded case circuit breakers sized to accommodate the motor starting inrush currents, in NEMA enclosures specified or as required for environment present. Furnish 3 pole, single throw circuit breakers unless otherwise indicated, with voltage and current ratings as indicated. Short circuit rating shall not be less than 25,000 A.I.C.

B. Interlocking: Provide means for triple padlocking the operating handle in the "off" position such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch cannot be closed. Equip switches with auxiliary contacts when such are indicated.

C. Enclosed circuit breakers shall be furnished and installed as indicated on the drawing, with ampacities as indicated.

D. Enclosed circuit breakers inside of building shall be NEMA 1.

E. Enclosed circuit breakers mounted exterior of the building shall be NEMA type 3R.

F. Manufacturers: Provide one of the following:

1. Eaton Cutler-Hammer
2. General Electric
3. Siemens
4. Square D

PART 3 - EXECUTION

3.1 EQUIPMENT SUPPORTS

A. Mount all electrical equipment, not self supporting, including enclosed switches and circuit breakers securely to walls and columns with 1/4 inch minimum separation from same, and provide all necessary spacers, brackets, structural pieces, inserts, anchors and bolts for this purpose. For equipment fastened to exterior walls below grade, use 1/2” spacers. Safety switches and enclosed circuit breakers shall be mounted on separate structures from HVAC housings, duct work, exhaust fans, pump frames, etc.

3.2 EQUIPMENT IDENTIFICATION

A. Safety switches and enclosed circuit breakers shall be provided with name plate indicating equipment controlled by that particular device.

B. Provide identification on all electrical equipment installed. Refer to Section 26 0553.

3.3 TOUCH-UP PAINTING

A. On all equipment installed, touch-up paint all manufacturer's standard finished equipment surfaces damaged during construction to "as new" condition with original manufacturer's finish paint.

END OF SECTION 26 2816

SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Motor control as required, and all material and equipment, including:

a. Control devices.
b. Safety switches.
c. Fuses.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Submit shop drawings and product data on the following:

1. Three phase magnetic motor starters full voltage combination type.
2. Three phase manual motor starters full voltage type.
3. Single phase manual motor starters fractional horsepower type.
4. Control devices.
5. Safety switches.
6. Fuses.

PART 2 - PRODUCTS

2.1 THREE PHASE MAGNETIC MOTOR STARTERS FULL VOLTAGE COMBINATION TYPE

A. Single-Speed Non-Reversing Starters: Per NEMA Standard ICS and consisting of a fused or non-fused disconnect switch, motor circuit protector, or circuit breaker as indicated, a full voltage magnetic starter, thermal overloads, control transformer and control devices as indicated and as specified, all mounted and wired in a NEMA 1 enclosure in indoor areas and NEMA 3R in outdoor areas unless otherwise indicated.

1. Non-fused Disconnect Switch: 600 volt, 3 pole, single throw, visible blade, NEMA "HD" heavy duty, quick-make, quick-break type, horsepower rated in ratings up to 200 amperes, with continuous current rating as required by NEMA Standards. Silver or cadmium plate all contact surfaces.
2. Fused Disconnect Switch: 600 volt, 3 pole, single throw, visible blade, NEMA "HD" heavy duty, quick-make, quick-break type, horsepower rated in ratings up to 200 amperes, with continuous current fuse ratings as indicated. Where ratings are not indicated, provide fuse clips to accommodate a dual element type fuse as specified and having a minimum current rating of 150% of the motor full load current, with switch of equivalent rating. Silver or cadmium plate all contact surfaces including fuse clips.

3. Motor Circuit Protector: Molded plastic case type, 3 pole, quick-make, quick-break, with trip-free common operating handle, position indication, and common trip from an adjustable magnetic-only element which provides instantaneous short circuit protection. For energy-efficient motors, the mechanism shall be an appropriate transient inrush suppressor type. A manual push-to-trip button shall be provided. The application fault duty shall not exceed the manufacturer's listed rating for the motor circuit protector in combination with the starter contactor and overload devices.
4. Circuit Breaker: Molded plastic case type, 3 pole, quick-make, quick-break, AC rated, with a trip-free common operating handle, position indication, common trip from a thermal magnetic trip device of trip rating indicated and with minimum interrupting capacity of (14,000) (22,000) (30,000) (50,000) (65,000) RMS symmetrical amperes at 480 volts AC. Where trip ratings are not indicated, provide trip ratings of approximately 250% of motor full load current.
5. Interlocking: Equip switch or breaker with an external operating handle. Interlock the operating handle such that the door cannot be opened unless the switch or breaker is in the "off" position. Provide means for padlocking the operating handle in the "off" position with three 5/16 inch shackle padlocks such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch or breaker cannot be closed.
6. Starter: Size starters per NEMA Standards for the horsepower of the motors with which they will be used, except do not furnish starters smaller than NEMA Size 1 for motors of 5 horsepower or less. Provide coils for operation on 120 volts AC unless other requirements are indicated. Equip each starter with a minimum of two convertible auxiliary contacts in addition to the normally-open seal-in contact, unless additional requirements are indicated. Provide additional contacts as indicated.
7. Thermal Overload: One in each phase wire, externally manual reset type. Select overloads after final installed horsepower of motor is determined. Do not use ratings exceeding 100% of motor full load current adjusted for ambient temperatures.
8. Control Transformer: Provide a 480-120 volt control transformer in the starter enclosure, except where a common 120 volt control power source is indicated. Fuse and ground the secondary winding as indicated. Where indicating lights, solenoid valves or other control components are to be energized from the control transformer, increase the capacity of the control transformer proportionately for loading above the minimum requirements of the operating coil.
9. Control Devices: Provide control devices as specified, in starter enclosures when required by elementary diagrams.

B. Reversing Starters: Per NEMA Standard ICS and consisting of a fused or non-fused disconnect switch or circuit breaker as indicated, two full voltage magnetic starters, thermal overloads, control transformer and control devices as indicated and as specified, with similar features to those specified for single-speed non-reversing starters. Interlock starters mechanically and electrically to prevent both starters from being closed at the same time.

C. Two-Speed Starters: Per NEMA Standard ICS and consisting of a fused or non-fused disconnect switch or circuit breaker as indicated, two full voltage starters for two-speed two-winding type motors, two sets of thermal overloads, control transformer and control devices as indicated and as specified, with similar features to those specified for single-speed non-reversing starters. Interlock starters mechanically and electrically to prevent both starters from being closed at the same time, and provide an automatic sequence deceleration relay where starters supply two-speed cooling tower fan motors.

D. Manufacturer: Provide products of one of the following:

1. Cutler-Hammer/Westinghouse.
2. General Electric.
3. Siemens-ITE.
4. Square D.

2.2 THREE PHASE MANUAL MOTOR STARTERS FULL VOLTAGE TYPE

A. Single-Speed Non-Reversing Starters: Per NEMA Standard ICS and consisting of a full voltage manual starter and thermal overloads, as indicated and as specified, all mounted and wired in a NEMA 1, 1A (gasketed), 12 enclosure in factory areas and NEMA 3R enclosure in outdoor areas unless otherwise indicated.

1. Starter: NEMA Size M-1 equipped with two convertible auxiliary contacts and with toggle or push-button operator.
2. Toggle Operator: Trip-free, having position indication for "on", "off", "reset" and "tripped", and means for padlocking the operator in the "off" position such that the cover door cannot be opened.
3. Push-Button Operator: Trip-free "on" or "start" push button interlocked with "stop-reset" push button providing "tripped" indication and having means of padlocking the "stop-reset" push button in the "stop" position such that the cover door cannot be opened and the "on" or "start" push button cannot be depressed.
4. Thermal Overloads: One in each phase wire, externally manually reset type. Select overloads after final installed horsepower is determined. Do not use ratings exceeding 100% of motor full load current adjusted for ambient temperatures.

B. Reversing Starters: NEMA Standard ICS and consisting of two full voltage manual starters, thermal overloads, as indicated and as specified, with similar features to those specified for single-speed non-reversing starters. Interlock starters mechanically to prevent both starters from being closed at the same time.

C. Two-Speed Starters: Per NEMA Standard ICS and consisting of two full voltage starters for two-speed two-winding type motors and two sets of thermal overloads as indicated and as specified, with similar features to those specified for single-speed non-reversing starters. Interlock starters mechanically to prevent both starters from being closed at the same time.

D. Manufacturers: Provide products of one of the following:

1. Cutler-Hammer/Westinghouse.
2. General Electric.
3. Siemens-ITE
4. Square D.

2.3 SINGLE PHASE MANUAL MOTOR STARTERS FRACTIONAL HORSEPOWER TYPE

A. Single-Speed Starters for 115 Volt Motors: Per NEMA Standard ICS and consisting of a toggle-operated, or key-operated when indicated, single pole, quick-make, quick-break type starter, one thermal overload element, and pilot lights in cover when indicated all mounted in a NEMA 1 surface mounting enclosure, or with a stainless steel plate for flush mounting in an outlet box, as indicated. Provide means for padlocking the toggle operator in the "off" position. Provide a total of four keys for operation of key-operated starters.

B. Single-Speed Starters for 230 Volt Motors: Per NEMA Standard ICS and consisting of a toggle-operated, or key-operated when indicated, two pole quick-make, quick-break type starter, one thermal overload in each phase, and pilot lights when indicated, with similar features to those specified for starters for 115 volt motors.

C. Manufacturer: Provide one of the following:

1. Cutler-Hammer/Westinghouse Type MS.
2. General Electric CR101.
3. Siemens-ITE Class SMF.
4. Square D Class 2510.

2.4 CONTROL DEVICES

A. Push Buttons and Selector Switches: Heavy duty, oil-tight type, with contacts rated 10 amperes continuous, 600 volts AC, with legend plate and operation as indicated.

1. Manufacturer: Provide one of the following:

a. Cutler-Hammer/Westinghouse 10250T
b. General Electric CR104P
c. Siemens-ITE
d. Square D Class 9001, Type K

B. Indicating Lights: Heavy duty, oil-tight type with 6 volt lamp, integral 120-6 volt transformer, push-to-test feature, color cap and legend plate as indicated.

1. Manufacturer: Provide one of the following:

a. Cutler-Hammer/Westinghouse 10250T
b. General Electric CR104P
c. Siemens-ITE
d. Square D Class 9001, Type K

C. Control Relays: Heavy duty industrial type with convertible contacts rated 10 amperes continuous, 300 volts AC. Provide coils for operation on 120 volts AC unless other requirements are indicated. Provide number and type of contacts as indicated.

1. Manufacturer: Provide products of one of the following:

a. Cutler-Hammer/Westinghouse
b. General Electric
c. Siemens-ITE
d. Square D

D. Timing Relays in General: Electrically-operated, pneumatically-controlled type, convertible from time-delay after de-energization to time-delay after energization, or vice-versa, in the field, with timing range adjustable from 0.2 seconds to 180 seconds, repeat accuracy of plus or minus 10%, one single pole, double throw contact rated 10 amperes continuous, 300 volts AC, and coil for operation on 120 volts AC unless other requirements are indicated.

1. Manufacturer: Provide products of one of the following:

a. Cutler-Hammer/Westinghouse
b. General Electric
c. Siemens-ITE
d. Square D

E. Motor-Driven Timing Relays: As indicated.

F. Enclosures: NEMA 12 factory areas and NEMA 1 in other areas unless otherwise indicated.

2.5 SAFETY SWITCHES

A. General Description: Fusible or non-fusible as indicated, quick-make, quick-break, NEMA "HD" heavy duty visible blade type, horsepower rated in ratings up to 200 amperes at 600 volts and up to 400 amperes at 250 volts, in NEMA 1 enclosures in indoor areas unless otherwise noted. Furnish 3 pole, single throw switches unless otherwise indicated, with voltage and current ratings as indicated. Short circuit rating with fuses shall not be less than 50,000 A.I.C. Silver or cadmium plate all contact surfaces including fuse clips.

B. Interlocking: Equip switches with an external operating handle and interlock the operating handle with the cover door such that the cover door cannot be opened unless the switch is in the "off" position. Provide means for padlocking the operating handle in the "off" position such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch cannot be closed. Equip switches with auxiliary contacts when such are indicated.

C. Fuse Clips: Standard rejection type for dual element cartridge type fuses as specified unless otherwise required.

D. Manufacturers: Provide one of the following:

1. Cutler-Hammer/Westinghouse H-600
2. General Electric Type TH
3. Siemens-ITE
4. Square D Heavy Duty

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motors: Refer to Section 16025 "Electrical Systems" for furnishing and mounting responsibility for all electric motors. Motors 1/2 horsepower and larger are 460 volts, 3 phase, 60 hertz, and motors less than 1/2 horsepower are 115 volts, single phase, 60 hertz, unless other requirements are indicated. In all cases where the capacity or rating of equipment being furnished under this Section is based on the rating of equipment being furnished under other Sections, confirm such ratings before purchasing the equipment.

END OF SECTION 26 2913

SECTION 26 5100 – INTERIOR LIGHTING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Lighting systems as required, and all materials and equipment, including lighting fixtures, accessories and associated systems and equipment, as indicated or specified.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.
2. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data.
3. Certified results of laboratory tests for fixtures and lamps for photometric performance.

B. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs and emergency lighting and OFS Policy No. 2-19 referencing Section 5-9.2.1 of NFPA 101 (see emergency lighting submittal requirements).

E. Regulatory Requirements:

1. Furnish lighting fixtures and other equipment, including all modifications thereto and component electrical parts, listed by Underwriters' Laboratories as meeting National Electrical Code requirements and bearing the UL Label where such service is available for equipment specified.
2. All lighting fixtures with plastic lenses shall comply with the Michigan Department of State Police, Fire Marshal Division, Policy Letter 11-6, dated March 24, 1992, applying to schools, colleges, hospitals, institutions, nursing homes, etc. Shop drawings and product data fixture cuts of such fixtures shall be accompanied by an approved certification stating compliance with the above ruling for forwarding to the State Fire Marshal by the Architect/Engineer.

1.5 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last nine years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule on the drawings. No substitutions or alternates shall be accepted for lighting fixtures.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

F. Electromagnetic Interference Filters: Integral to fixture assembly. Provide one filter for each ballast. Suppress conducted electromagnetic interference filters as required by MIL-STD-461.

2.3 EXIT SIGNS

A. See lighting fixture schedule on drawings. Alternates will not be accepted.

2.4 LED

A. LED (Light Engine): Complies with IEC and FCC Standards.

1. LED color temperature: 3500°K for downlights, 4000°K for all other fixtures.
2. Operating Temperature: -40°C to +50°-C (-40°F to 122°F).
3. Operating Hours: Designed for 50,000+ hours of maintenance free operation.
4. Warranty: Limited 5 year warranty.
5. IP66 rated.
6. LM79 and LM80 compliant
7. UL listed.

B. Driver: Complies with IEC and FCC standards.

1. Driver: Remote LED Class 2 power supply.
2. Total fixture wattage should not exceed 90% of power supply rating.
3. Provides transient voltage protection in accordance with IEEE/ANSI C62.41.2 guidelines.
4. Input Voltage 120-277AC, Output Voltage 24V DC
5. Warranty: 5-year warranty.
6. UL listed.

2.5 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Sections for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.6 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Support for Fixtures in Grid-Type Suspended Ceilings:

1. Install a minimum of two ceiling support system rods or wires independent from the ceiling grid “T” for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests 5 business days prior to testing.

C. Provide instruments to make and record test results.

D. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

F. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 26 5100

SECTION 28 3111 - FIRE ALARM SYSTEM - ADDRESSABLE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this section.

1.2 SUMMARY

A. This Specification provides the requirements for the installation of a complete point-addressable type manual and automatic fire detection system network. The system shall include, but not be limited to: Control panel, remote annunciator panel, alarm initiating and indicating peripheral devices, fire door holders, conduit, wire and accessories required to finish a complete operational system including a communication link that provides the transmission of the status of the fire alarm system via two (2) dedicated telephone lines, to a remote off-site command station.

B. The system specified herein will provide emergency/voice alarm notification throughout the entire facility. That is, voice notification is required in both the new and existing portions of the building. All notification devices in the existing building are to be replaced.

C. The completed system shall be certified on State Fire Marshal Form FM-12A in accordance with Public Act 144.

1.3 FIRE ALARM AND PROTECTIVE SYSTEM SEQUENCE OF OPERATION

A. The operation of a manual station or activation of any area smoke detector, duct smoke detector, thermal detector, sprinkler water flow switch, or any automatic alarm initiation device shall automatically:

1. Sound all alarm signals (Code 3) throughout the building.
2. Flash all alarm lights/strobe throughout the building. Silencing the devices (audible circuit) shall not automatically turn off flashing alarm lamp/strobes.
3. Operate prioritized outputs to release all smoke doors and magnetically-locked doors throughout the building.
4. Initiate the transmission of an alarm to central stations selected by the Owner or his representative. This selection, its fees and fees for any telephone lines are the sole responsibility of the Owner or his representative.
5. Visually indicate via the control panel LCD or an alarm LED, the addressable device of the circuit of alarm initiation. When the control panel goes into the alarm condition the (GREEN) NORMAL LED shall extinguish and the (RED) ALARM LED shall light, the BUZZER shall pulsate and the first line of the 80 character LCD shall indicate the REAL TIME, the number of MESSAGES WAITING< the TYPE OF ALARM, the ALARM ZONE NUMBER, and the TIME THAT THE ALARM OCCURRED>. The second line shall display the user specified message. In order to reduce false alarms, all inputs shall be capable of alarm verification. The system shall be capable of setting the sensitivity of all analog sensors by point and be capable of displaying the analog value of the sensor by device and/or traditional input and vectoring the value to the printer. The system shall automatically identify any analog sensor which becomes dirty (maintenance alert) prior to false alarming.
6. Upon operation of the associated duct smoke detector, the air handling systems shall be deactivated so as to prevent the recirculation of smoke. Such actions shall override the regular mechanical systems controls.
7. All smoke detector circuits shall be provided with alarm verification with adjustable time from 0 to 60 seconds. Time to set at 10 seconds.
8. A break in the initiating loop wiring shall light both the common trouble lamp and the respective zone trouble lamp on the control unit, as well as sound a trouble signal at the fire alarm control panel.
9. A break in the indicating loop wiring shall light the common trouble LED and "Indicating Loop Trouble" LED on the fire alarm control unit, as well as sound a trouble signal at the fire alarm control unit.

B. The operator shall acknowledge the alarm by pressing the acknowledge button, and the buzzer will silence providing there is not an additional alarm pending. If there are additional alarms waiting, the operator shall acknowledge all pending alarms before the buzzer will silence. To silence audible devices, the operator shall press the ALARM SILENCE button, a new alarm shall cause the audibles to resound. To reset the system, the operator shall press the RESET button.

C. Activation of a supervisory condition such as a sprinkler valve tamper switch, etc. shall automatically:

1. Display on the control panel LCD the zone or the addressable device from which the off normal (active point) condition was initiated. During the SUPERVISORY condition the amber SUPERVISORY LED shall light, the NORMAL LED shall go out, and the BUZZER shall pulsate. The LCD shall indicate ("SUPERV. SHORT") and the zone/ device number. The operator shall silence the buzzer by acknowledging all messages and pressing the TROUBLE SILENCE button.
2. Operate the prioritized output to initiate transmission to the central station.
3. Supervisory alarms shall be differentiated from trouble condition on circuit.

1.4 STANDARDS

A. The equipment and install shall comply with the current provisions of the following standard:

1. National Electric Code, Article 760 and applicable standards of NFPA 90A including (not an inclusive list):

   a. NFPA 72A National Fire Alarm Code.
   b. NFPA 101 Life Safety Code.

2. Local and State building codes.
3. Local authorities having jurisdiction: ULC, CSFM, BSA, State Fire Marshal.
4. Underwriters' Laboratories, Inc.

B. The system and all components shall be listed by Underwriters' Laboratories, Inc. for use in fire protective signaling system under the following standards as applicable:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems".
2. UL 217, "Single and Multiple Station Smoke Detectors".
3. UL 268, "Smoke Detectors for Fire Protective Signaling Systems".
4. UL 268A, "Smoke Detectors for Duct Applications".
5. UL 464, "Audible Signal Appliances".
6. UL 521, "Heat Detectors for Fire Protective Signaling Systems".
7. UL 864, "Control Units for Fire Protective Signaling Systems"
8. UL 1480, "Speakers for Fire Protective Signaling Systems".
9. UL 1971, "Signaling Devices for the Hearing Impaired".

1.5 RELATED WORK PROVIDED BY OTHERS

A. Furnished and installed under a separate contract, but wired as part of the work of this Section.

1. Water flow switches, gate valve supervisory switches and post indicator valve switch.

1.6 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

1. Shop Drawings: Submit detailed point-to-point wiring diagrams and installation instructions. Shop drawings shall show color coding of connections and mounting dimensions of equipment.
2. Product Data: Submit product data for each fire alarm system component specified.

B. A complete set of shop drawings shall be submitted to the State of Michigan (SOM) Office of Fire Safety for approval in accordance with Act 144 of 1982. Shop drawings shall be approved by the SOM and all SOM comments reflected on the documents prior to submission of the shop drawings to the Engineer for approval. Shop drawings submitted to the Engineer prior to SOM approval will be returned - rejected.

C. The Contractor shall submit complete sets of documentation within 30 calendar days after award of purchase order. Indicate the type, size, rating, style, catalog number, manufacturers' names, photos, and/or catalog data sheets for all items to ensure compliance with these Specifications. This equipment shall be subject to his approval and no equipment shall be ordered without this approval. Equipment devices are shown on the Contract Drawings, provide shop drawings as follows:

1. Complete one-line riser diagram showing all equipment and the size, type and number of all conductors.
2. Drawing of typically multiplexed field panel.
3. Provide calculations to support the size of standby batteries submitted.
4. Include programming and installation manuals.

D. At Contract close-out deliver six (6) copies of the following to the Owner's Representative within thirty (30) days of date of system acceptance:

1. Installation and programming manuals covering the installed system.
2. Point-to-point diagrams of the entire system as installed. Number all conductors and show all terminations and splices.
3. The application program listing for the system as installed at the time of acceptance.
4. Name, address, and telephone of the authorized factory representative.

1.7 WARRANTY

A. Warranty all materials, installation and workmanship for one (1) year from date of acceptance, unless otherwise specified.

1.8 MAINTENANCE

A. Maintenance and Service Contract: Submit a maintenance and service contract with service rates covering all labor and materials necessary to repair damages to the system. The service contract shall include a differentiation between and definitions of "emergency" and "non-emergency" service with applicable rates for each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide products by one of the following:

1. National Time & Signal
2. Simplex Grinnell

2.2 CONTROL PANEL

A. The Fire Alarm Control Panel shall be an addressable modular panel with solid state, microprocessor based electronics. It shall display only those primary controls and displays essential to operation during a fire alarm condition.

B. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of onsite programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

1. Full flexibility for selective input/output control functions based on ANDing, ORing, NOTing, timing and special coded operations shall also be incorporated in the resident software programming of the system.

C. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.

D. The control panel shall provide the following:

1. Setting of time and date.
2. LED testing.
3. Alarm, trouble, and abnormal condition listing.
4. Enabling and disabling of each monitor point separately.
5. Activation and deactivation of each control point separately.
6. Changing operator access levels.
7. Walk test enable.
8. Running diagnostic functions.
9. Displaying software revision level.
10. Displaying historical logs.
11. Displaying card status.
12. Point listing.
13. Connections to a remote off-site command station via a communication link.

E. For maintenance purposes the following lists shall be available from the point lists menu:

1. All points list by address.
2. Monitor point list.
3. Signal/Speaker list.
4. Auxiliary control list.
5. Feedback point list.
6. Pseudo point list.
7. LED/Switch status list.

F. Primary Keys, LED's and LCD Display: The Control Panel shall have a 2 line x 40 character liquid crystal display which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity. The display shall support both upper and lower case letters. Lowercase letters shall be used for softkey titles and prompting the user. Uppercase letters shall be used for System Status information. A cursor shall be visible when entering information.

G. History Logging: The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event's occurrence.

1. The following Historical Alarm log events shall be stored:

a. Alarms
b. Alarm Acknowledgment
c. Alarm Silence
d. System Reset
e. Alarm Historical log cleared.

2. The following Historical Trouble log events shall be stored:

    a. Trouble conditions
    b. Supervisory alarms
    c. Trouble acknowledgment
    d. Supervisory acknowledgment
    e. Alarm verification tallies
    f. Walk test results
    g. Trouble Historical log cleared

H. Silent Walktest with History Logging: The system shall be capable of being tested by one person. While in testing mode the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical date file. The panel shall automatically reset itself after logging of the alarm. The momentary disconnection of an initiating or indicating device circuit shall be silently logged as a trouble condition in the historical data file. The panel shall automatically reset itself after logging of the trouble condition.

I. Access Levels: Provide a minimum of four (4) access levels with level 4 being the highest level. Level 1 actions shall not require a passcode. Passcodes shall consist of up to ten (10 digits. Changes to passcodes shall only be made by authorized personnel.

J. Communication with Addressable Devices: The system shall provide communication with initiating and control devices individually. All of these devices shall be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

    1. Alarm
    2. Trouble
    3. Open
    4. Short
    5. Device Missing/Failed

K. All addressable devices shall have the capability of being disable or enabled individually.

L. Up to 127 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices shall not be acceptable.

M. Identification of Addressable Devices: Each addressable device shall be uniquely identified by a dip switch address entered on each device at time of installation. The use of jumpers to set address shall not be acceptable due to the potential of vibration and poor contact. Device identification schemes that do not use uniquely set addresses but rely on electrical position along the communication channel are unacceptable. These systems cannot accommodate T-tapping because the addition of an addressable device between existing devices requires reprogramming of all existing electrically further devices.

N. All controls and visual indicators shall be located behind key-locked doors and windows to prevent tampering and unauthorized operation. Access shall be to the switches only and shall not expose wiring or components. The unit enclosure shall be key-locked to prevent unauthorized access. The unit enclosure shall be semiflush mounted with module termination drawings mounted on the inside of the panel cover.

O. Actuation of the disconnect switch shall light a disconnect trouble lamp and cause the local system trouble signal to operate.

P. The fire alarm panel shall provide a communication link to transmit the status of the fire alarm system to a remote of-site command station via dedicated telephone line.

Q. Provide modems at both ends of the communication link and appropriate software, including conduit and wiring. The dedicated telephone line will be provided by others.

R. Supplementary Relay Controls: Provide alarm activated relays as pilot controls for fan shutdown, door release, elevator recall, etc., as indicated on the Drawings and control diagrams.

S. System Power Failure Indicator: Provide a system power failure indicator to supervise the AC supply voltage to the fire alarm control unit. The unit shall contain a battery, automatic charger, and "power on" indicator.

T. Standby batteries shall be capable of operating the fire alarm system for a minimum of 24 hours and then operating all indicating units for at least five minutes. Batteries shall be placed in the fire alarm control unit or similar type enclosure located next to the control unit.

2.3 NODE AND NAC PANELS

A. Node and NAC panels shall be modular with solid state, microprocessor based electronics, operator interfaces, power supplies, audio generators, amplifiers, battery chargers and batteries as required. All components shall be supervised.

2.4 BATTERIES

A. Batteries shall be lead calcium and supervised so that a failure produces a "TROUBLE" signal.

2.5 REMOTE ANNUNCIATOR

A. The remote annunciator shall duplicate the backlit LCD display; the alarm acknowledge, supervisory acknowledge, trouble acknowledge, alarm silence, and system reset pushbuttons; the alarm, supervisory, and trouble audible signals; the alarm, supervisory, trouble, and power "on" LED’s; and the programmable function keys of the fire alarm control panel. A key "enable" switch or door lock, keyed to match the fire alarm control panel door lock, shall permit activating or deactivating the controls.

B. A remote microphone shall be included when the fire alarm system includes emergency voice/alarm communications, along with the same pushbuttons as the fire alarm control panel for selecting pre-recorded voice messages, and the same controls to choose total building or selected areas communications.

2.6 ADDRESSABLE SPOT DETECTOR BASES

A. Spot detector mounting bases shall be individually addressable, suitable for two wire operation, with a twist-lock head locking feature a DIP switch or electronic addressing means, and an LED that provides power "on", alarm and trouble indications. The bases shall be listed for ceiling and wall mounting. Removal of the detector head shall cause a trouble condition at the panel.

B. Where shown, the bases shall include an auxiliary relay that is controlled from the panel.

C. When bases are not in plain view, bases shall be connected to remote alarm indicators mounted in plain view at 48 inches above the floor.

2.7 MULTISENSOR SMOKE DETECTOR HEADS

A. Multi-sensor type smoke detector heads shall include sampling and reference ionization chambers with a single radioactive source, a photoelectric sensor and a programmable heat detector. The detectors shall support at least four levels of sensitivity selectable at the panel and 360 degree smoke entry.

2.8 PHOTOELECTRIC SMOKE DETECTOR HEADS

A. Photoelectric type smoke detector heads shall include a pulsed LED light source and a silicon photodiode receiver, at least seven levels of sensitivity selectable at the panel, an integral insect screen and 360 degree smoke entry. This type of detector shall be installed in all duct detectors.

2.9 HEAT DETECTOR HEADS

A. Heat detector heads shall include combination rate-of-rise and rate compensated fixed temperature sensing, two levels of rate-of-rise sensitivity selectable at the panel, and an independent 135 degrees F fixed temperature set point. Heat detector heads shall be self-restoring.

B. Heat detector heads for steam tunnels, cage wash areas and dish machine areas shall have a 135 degrees F fixed temperature set point and shall be self-restoring.

2.10 DUCT DETECTORS

A. Duct detectors shall be individually addressable and consist of a housing, sampling tubes, a baffle and a detachable detector head. Duct detectors shall include an alarm LED, a local test switch, and an auxiliary SPDT relay for ventilation system control. Duct detectors shall be resettable by actuating the panel reset pushbutton. The sampling tubes shall be capable of being cleaned through the housing cover.

B. The detector heads shall be photoelectric as specified above, but shall be capable of accepting ionization detector heads.

C. When not in plain view, duct detectors shall include remote alarm indicators and test switches mounted in plain view at 48 inches above the floor.

2.11 MANUAL PULL STATIONS

A. Manual pull stations shall be individually addressable, suitable for two wire operation, with a high impact red Lexan body and raised white lettering. Stations shall include an ADA compliant single action operating mechanism with a mechanical latch to hold an operated station open until reset.

B. Reset shall be accomplished through use of a key common to the panel or a small flat-blade screwdriver. Stations which use allen wrenches or special tools to reset are not acceptable. The point of reset shall be front accessible so stations with tamper-resistant covers can be reset easily.

2.12 MONITOR MODULES

A. Monitor modules for individual two wire contact monitoring shall be individually addressable, suitable for two wire operation, with a DIP switch or electronic addressing means, and a programmable latch feature for monitoring momentary contacts. Monitor modules shall monitor a single normally open dry contact using a Class B, Style B, initiating device circuit.

B. Monitor modules for zone or four wire device monitoring shall be individually addressable, suitable for four wire operation utilizing 24 volt DC power from the panel, and with a DIP switch or electronic addressing means. Zone monitor modules shall monitor multiple normally open dry contacts using a Class B, Style B, two wire initiating device circuit, or monitor a four wire device using a Class B, Style D, four wire initiating device circuit.

2.13 CONTROL MODULES

A. Control modules shall be individually addressable with DIP switches or electronic addressing means. Control modules shall provide either one normally open and one normally closed contact or a Form C contact per digital output. Control modules may have more than one digital output per module if each output has a unique address. Contacts shall be rated 0.5 amps at 120 volts AC or 2 amps at 28 volts DC resistive and shall be controlled by the panel.

2.14 SPEAKERS

A. Speakers shall be rated 125 to 12,000 Hertz, include four taps rated at from 1/4 to 2 watts, produce a sound level of 82 dBA at 10 feet when set at the 1/2 watt tap, and with a semi-flush body capable of wall or ceiling mounting.

B. Speakers for locations with high ambient noise may be high efficiency horns rated 500 to 6,000 Hertz minimum, 10 watts minimum, include four or more taps, produce a sound level of 106 dBA minimum at 1 meter when set at the 1 watt tap, and be capable of wall or ceiling mounting.

2.15 STROBES

A. Strobes shall be rated 15, 30, 60, 75, 110 or 177 candela as shown for proper illuminance, with a 1 Hertz flash rate, Xenon flash tube, white body, clear Lexan lens with red "FIRE" or international fire symbol lettering, capable of being synchronized, and capable of wall or ceiling mounting.

2.16 COMBINATION HORN/STROBES AND SPEAKER/STROBES

A. Combination horn/strobes and speaker/strobes shall consist of the horns, speakers and strobes specified above, but combined on a single mounting plate. Combination units used outdoors and in wet areas shall be waterproof and mounted to waterproof back boxes.

2.17 DOOR HOLD-OPEN POWER SUPPLY

A. The door hold-open power supply shall produce 24 volts DC of sufficient amperage to provide 0.4 amps of current to every door hold-open device being controlled. The power supply shall be supervised and capable of withstanding the inrush current that will occur when the door hold-open devices are energized.

B. The output of the power supply shall be distributed by individually fused circuits. Fuse each circuit at 5 amps.

C. The power supply shall release the held open doors upon a fire alarm or an AC power failure.

2.18 EMERGENCY VOICE/ALARM COMMUNICATIONS

A. Emergency voice/alarm communications shall include audio control modules for evacuation tone and voice message generation, controls to choose total building or selected areas communications, audio amplifiers, a local microphone, and a remote microphone at each remote annunciator. All of the components except for the remote microphones shall be located in or adjacent to the fire alarm control panel.

B. The audio control module default mode shall provide for automatic total building fire alarm evacuation. The evacuation tone shall consist of a three-pulse temporal pattern followed by a pre-recorded fire alarm voice message. At the end of each voice message, the evacuation tone shall resume. The evacuation tone and voice message shall sound alternately until the alarm silence pushbutton at the fire alarm control panel or remote annunciator has been pressed. Audio tones and voice messages shall be digitally transmitted between nodes.

C. The audio control modules shall provide for manual total building or selected area live voice communications. Upon keying of the local or a remote microphone, a three second continuous alert tone shall sound over the speakers indicating a live voice message will occur.

D. The evacuation and alert tones shall be digitally generated by programmable software so that changes can be made without component rewiring. The pre-recorded voice messages shall be stored digitally in non-volatile EPROM memory.

E. Audio amplifiers shall have a frequency response of 125 Hz to 12,000 Hz minimum.

F. Microphones shall be of a hand-held, push-to-talk, noise-canceling type with a frequency range of 200 Hz to 4000 Hz and a self-winding five foot coiled cable. An LED shall indicate the microphone push-to-talk pushbutton has been pressed and the speaker circuits are ready for transmission.

G. Remote microphones shall be enclosed in remote annunciator cabinets with lockable doors.

1. Remote microphones shall duplicate the manual voice transmission capability of the local microphone at the fire alarm control panel. The fire alarm control panel microphone shall have priority over any remote microphones.
2. The remote microphone cabinets shall include controls for total building or selected areas communications.

H. Should a Fire Department telephone communication system be provided, the telephones system shall be capable of being patched to the emergency voice/alarm communications system and controlled at the fire command center.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System shall be installed with dedicated conduits, conductors, outlet boxes, fittings, connectors and accessories necessary to ensure a complete, operable system in compliance with all applicable codes and regulations.

B. Install all equipment at locations indicated, and secure to ceilings, walls, floors or structural members as required.

C. Provide final wiring and connections per the manufacturer's wiring diagrams. Wiring for the fire alarm system shall be in separate conduits from any other system.

D. Outlet, pull and junction boxes shall be installed in accordance with Section 26 0533.

E. All fire alarm system conduits and outlet boxes shall be marked and labeled.

F. T-tapped connections will not be allowed on any supervised circuits. Connections shall be directly to and from device terminal screws. Screw terminal shall have rising plates to terminate more than one wire or each wire shall be terminated to individual screws or each wire shall terminate in a ring lug.

1. Notification appliance circuits (NAC) shall be Class B.
2. Communication (initiating) circuits shall be Class A.

G. The location of smoke detectors in air ducts shall be as required by code and shall be accessible for maintenance. Duct smoke detectors shall be hard wired to shutdown associated air handlers.

H. Provide as-built wiring diagrams at completion of Project.

3.2 IDENTIFICATION

A. All junction box covers, conduit couplings and panels shall be painted red to match system manufacturer's hue.

B. Label all control and monitor modules and detectors with point numbers and function.

3.3 FIELD QUALITY CONTROL

A. Adjusting: After completion of system wiring, connect, test, adjust, and readjust as necessary, all equipment in terms of design function and performance.

1. Provide equipment to check the calibration of instruments. Instruments not in calibration, shall be recalibrated to function as required, or shall be replaced.
2. Calibrate and adjust devices, linkages, accessories, and components for stable and accurate operation to meet the design intent and to obtain optimum performance from the equipment. Final adjustment, calibration and checking shall be performed while the system is in full operation. Cause every device to automatically function as intended to insure its proper operation.

B. Demonstration: After calibration, adjustment, and checking have been completed and system is operational, demonstrate to the governing authorities having jurisdiction and to the Architect-Engineer the complete and correct functioning of all system components and equipment. These demonstrations shall consist of operating the controls through their normal full ranges and sequences. Simulate abnormal conditions to demonstrate proper functioning of the devices. Readjust settings to their correct design values and after sufficient time, observe ability of controls to establish the desired conditions, noting abnormal deviations. Make necessary repairs, replacements or adjustments on items which fail to perform satisfactorily and repeat tests to demonstrate compliance with the design intent.

1. When system is in specified operational condition, and when pertinent operational functions have been demonstrated, system will be accepted.

END OF SECTION 28 3111